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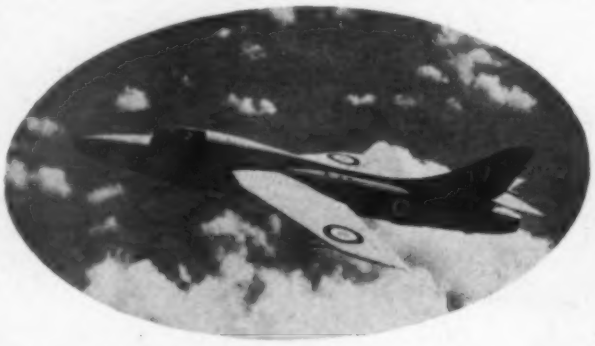

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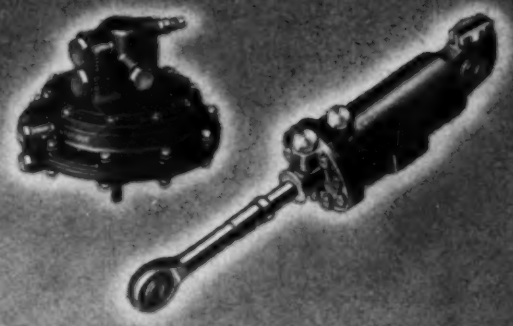

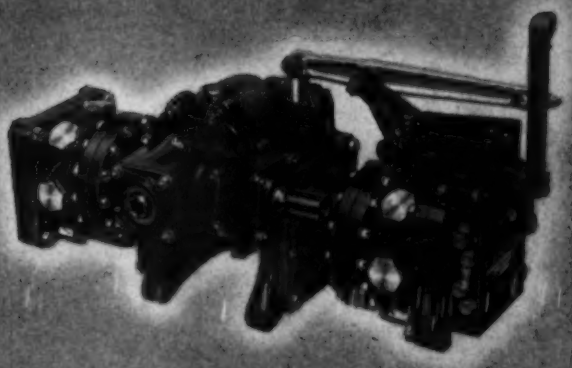

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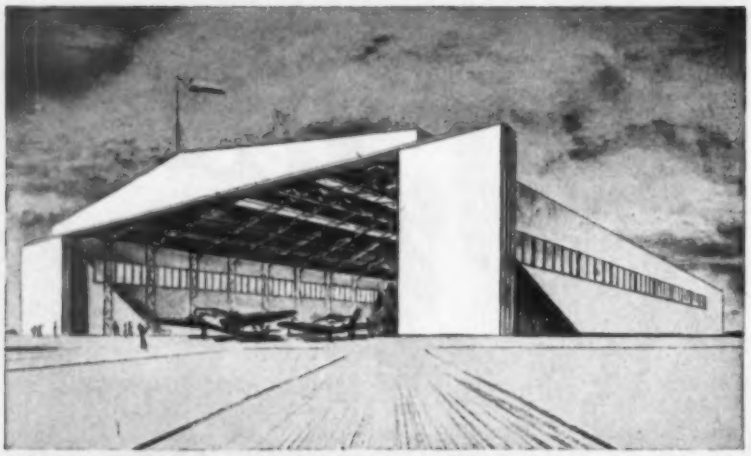
2% Mn. 2% Al.	36.0	44.0	20.0	240
4% Mn. 4% Al.	58.0	62.0	18.0	300
6% Al. 4% V.	58.0	63.0	22.0	300
Complex Al. alloy	64.0	72.0	15.0	360



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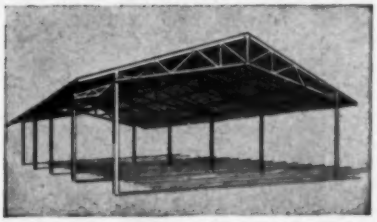

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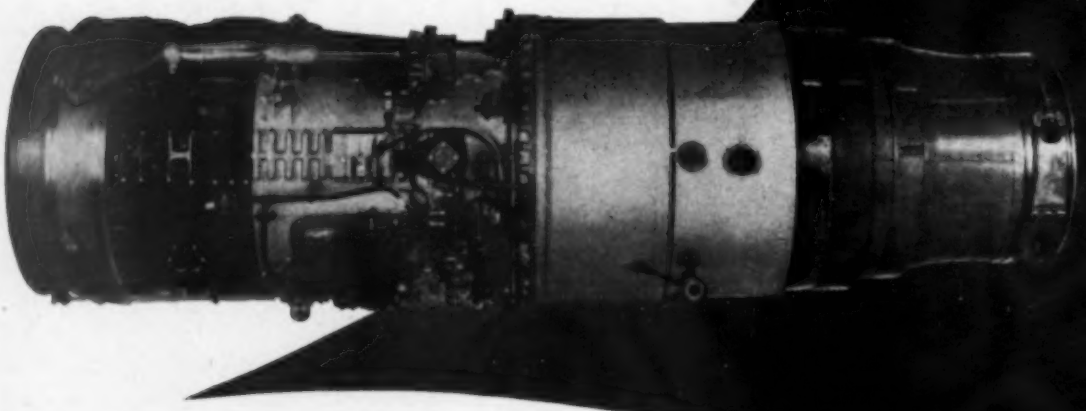

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FLIGHT and AIRCRAFT ENGINEER

No 2572 Vol 73 FRIDAY 9 MAY 1958

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Force and Flair

MORE than once we have detailed the merits of the manned military aeroplane compared with the most intelligent missile; but we do not recall having stressed its value as a vehicle for showing the flag. We have in mind not so much its ability to display military strength and preparedness in skies which may be clouded by international trouble (the visit of the four Canberras to British Honduras, recorded in this issue, is considered by some observers to be a topical instance). Rather we are thinking of the more overt "goodwill" type of visit, as performed at Stavanger over the weekend by the fabulous Hunters of "Treble One." These sleek black beauties have opened the season of international displays with an act which, if the picture on page 623 is evidence, will win them new rosettes.

The propaganda value of such demonstrations derives not only from consummate flying skill and zestful presentation, but from scrupulous attention to significant details. In this regard, those responsible must be congratulated on having achieved, for instance, a really dense smoke-trail; and a new departure from standard Service markings is another manifestation of the real sense of showmanship which has marked the preparations. It has rightly been recognized that the R.A.F. is not unchallenged in the formation-aerobatic field, and that a crowd can easily be satiated—indeed, positively bored—with successive appearances by teams from the U.S.A., Great Britain, France, Italy, Sweden and other nations, even though all may be in the first league. There is an increasing recognition of the need for doing, or showing, something different from the others, though (as in any field of entertainment) this is more easily advocated than achieved.

We can at least be satisfied that the R.A.F. team for 1958 takes the field well mounted, fully practised, fittingly uniformed, and with a certain little something up their sleeves; and anyone who has sensed the mood of foreign crowds hundreds of thousands strong will agree that this consideration is a weighty one. In showing the flag as much can be achieved by flair as by strength.

Something for the Middleman?

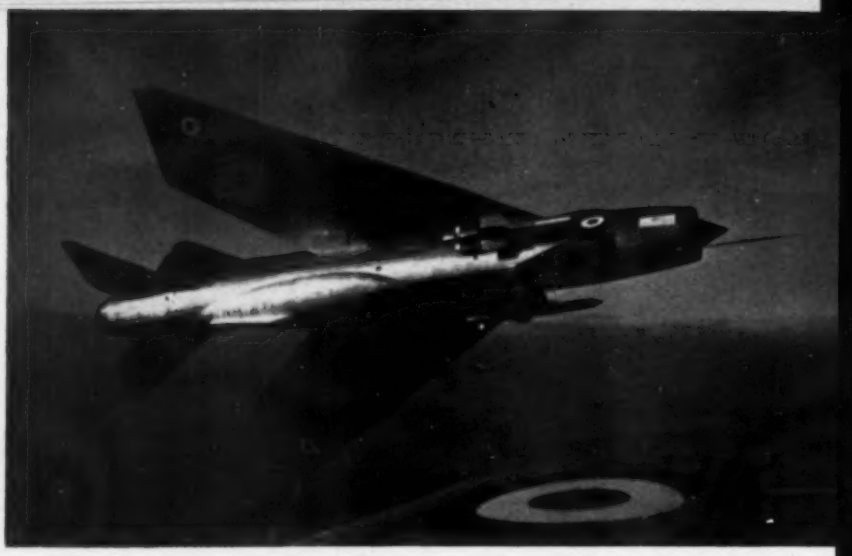
LIGHT aviation's middleman has a complaint to make. He is the prospective private owner, and he stands mid-way between the ultra-light amateur constructor and the high-powered, expense-accounted operator of an all-metal executive aircraft. His complaint is that there are too few suitable aircraft in this country for him to buy and fly. And he was particularly interested to see, in the *Royal Aero Club Gazette* recently, a suggestion by A. Cdre. G. J. C. Paul for an enclosed side-by-side two-seater, costing not more than £1,300 to buy (this implied adaptation of an existing design) and thirty shillings per hour to operate.

It has already been commented that, thanks to the Rollason organization and its licence-built Druine Turbulent, the number of British companies making light aircraft has been doubled. From one to two. The delightful Turbulent, factory-built at about £1,000, is an excellent thing, but the prospective private owner no more wants to fly solo all the time than he wants to buy a single-seater sports car. Neither does he forget the Jackaroo; but it is a *new* design that he seeks.

The lead in post-war popular sporting flying has gone decisively to France, where club and private pilots enjoy effective government support. And what of Federal Germany, a country which began power flying again only three years ago? At Hanover last week *Flight* saw at first-hand the impressive achievement of those three years. This (as reported on pages 650-651) included a factory-built Turbulent for £1,100; an indigenous two-seater for £1,800; the unique and practical RW.3 two-seater at about £2,500; and three other original 2-4 seater designs.

The answer to the middleman's complaint could come in either of two ways. Firstly, the British aircraft firms who until now have concentrated on defence orders might choose to design and construct a sports aeroplane. Alternatively, they can licence-build a Continental design. And if one of them selected the Jodel D.117, the Druine Condor or the C.P. Emeraude, for example, how's that for three good answers to the air commodore's prayer?

FROM ALL QUARTERS



SIDE-ARMS: Equipped with two flank-mounted de Havilland Firestreak missiles and 30 mm Aden guns is this English Electric P.1B development aircraft. More than a thousand flights have been made on P.1s by some 25 different pilots, and the makers report that progress is being made with the development of the armament system, which is to include an airborne electronic computer. Firing trials have been conducted with both types of armament. This aircraft has the number XA 853.

"Prospect" Presented

WITH the Duke of Edinburgh and a representative cross-section of British life as audience—M.P.s, industrialists, professional men and journalists—the R.A.F. made the bold experiment last Tuesday of putting its policy and views before the public in a series of dramatic presentations. These were introduced by the Chief of the Air Staff, Marshal of the R.A.F. Sir Dermot Boyle, and each presentation—on defence policy, the deterrent, the R.A.F. overseas and the future—was followed by an open discussion. The conference, called "Prospect," followed a similar one under the same title for senior R.A.F. officers at Cranwell, and it was held at the Royal Empire Society's headquarters in London. Fuller reference to the conference will be made in our next issue.

NA.39 Flies

AFTER a delay consequent upon a burst tyre suffered during high-speed taxying trials on April 21, the first Blackburn NA.39 naval strike aircraft made its first flight on April 30. Powered by two de Havilland Gyron Junior turbojets, the aircraft is of exceptional technical interest and is the subject of an article beginning on page 627.

The prototype was brought by road from the maker's airfield at Brough, East Yorkshire, to the R.A.E., Bedford. The pilot on the first flight was Mr. Derek Whitehead, who was accompanied by Mr. B. J. Watson, head of the Blackburn flight test department. The first flight lasted 39 min and was highly satisfactory.

Golden Quarter

SINCE the end of the war the aircraft industry has earned more than £668m in overseas markets and it is today exporting more of its products in twelve weeks than it did in twelve months a few years ago.

In recording this remarkable increase the S.B.A.C. reports that the first quarterly total for 1958—£36,328,552—exceeded the annual export totals of every year up to and including 1950. It also represents an increase of 50 per cent over the January - March figure for last year, and 24 per cent over the 1956 total for the same period—which was, until now, the highest first quarterly figure yet recorded.

This year's March total—£12,179,511—was the fourth largest monthly figure ever achieved by the industry. It was made up as follows: aircraft and parts, £7,594,323; engines, £4,120,550 (the second highest monthly total ever); electrical equipment, £227,964; tyres, £40,521; instruments, £146,152. India was the best customer (£1,484,979), with Canada (1,228,106) and South Africa (£693,499) next.

So far, the industry's export effort during 1958 represents an annual rate of more than £145m, compared with last year's record total of £116½m.

JOHN LANKESTER PARKER, doyen of British flying-boat pilots and Short's chief test pilot for 28 years, recently retired from the company's board of directors. He is here being presented with a watch by Mr. L. Stedman, an old colleague and now Short's assistant technical manager (G.W.). Sir Matthew Slattery, chairman and managing director (right) displays a graphic tribute, based on a Sunderland.

New Aircraft and Engines

MENTION may now be made of the Hawker Hunter T.8, the navalized counterpart of the T.7 two-seater, fitted with an arrester hook, modified instrumentation and incorporating other detail differences.

The existence may also be disclosed of the de Havilland Gyron Junior DGJ.2 and Bristol Olympus BOl.7 turbojets, and of the Rolls-Royce Conway RCo.12, 14 and 15.

Handley Page Appointments

A SERIES of appointments within the organizations of Handley Page, Ltd., and Handley Page (Reading), Ltd., was announced last weekend.

After 40 years with the Cricklewood company, Mr. H. Smith, works manager, is to retire; but he has accepted an appointment as consultant, and his services in that capacity will be available to the company. He is succeeded as works manager by Mr. E. W. Pickston, who relinquishes his present post as manager of the Reading company.

IN H.P. POSTS: Messrs. Pickston, Robinson, Smith and Walker.

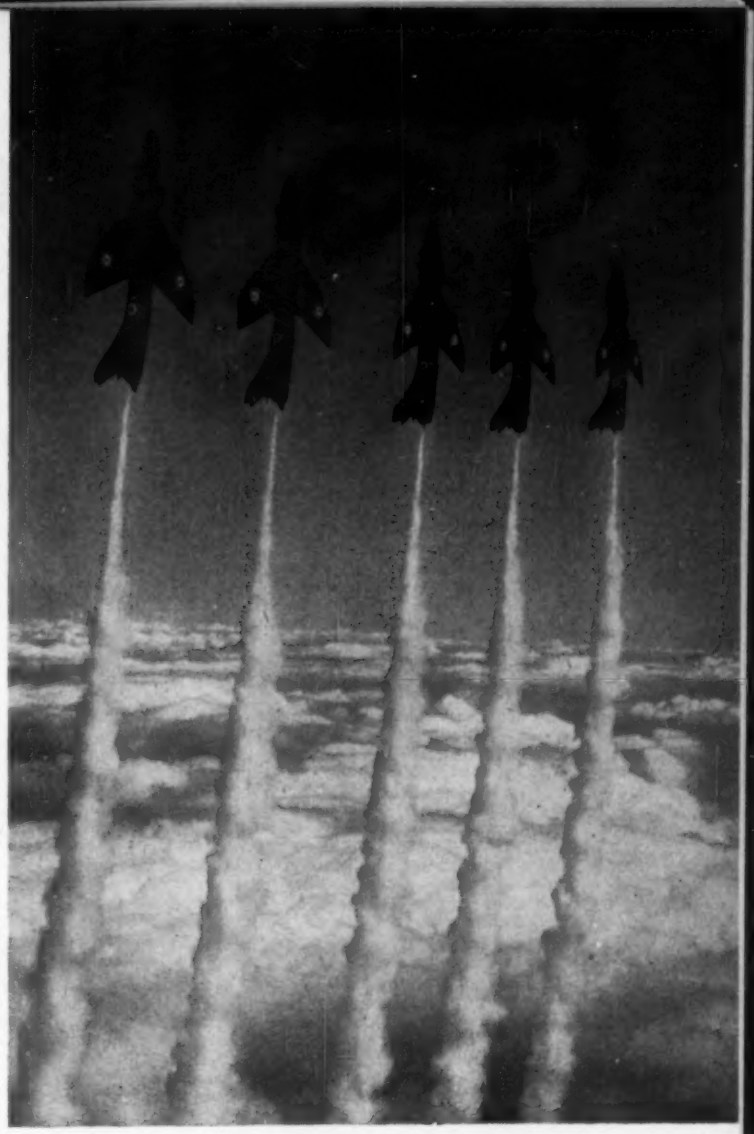
Mr. W. Eames has been appointed Handley Page assistant works manager, while Mr. W. Corbett succeeds him as superintendent of the company's aerodrome at Radlett. Mr. D. C. Robinson, works superintendent, is made chief engineer of the commercial division of Handley Page, Ltd.

Mr. E. Manley Walker has been appointed a director, and manager, of Handley Page (Reading), Ltd.; and, also in that company, Mr. J. Wilkinson becomes works manager.

Inertial Gyros in Britain

AN agreement has been signed between the English Electric Co., Ltd., Honeywell-Brown, Ltd., and Minneapolis-Honeywell Regulator Company under which the guided-weapons division of the first-named company is to produce a range of the most modern gyroscopes designed by the American company. These will include the well-known floated gyros used in inertial navigation systems.

English Electric have begun construction of a new assembly and test building at Stevenage. Vibrations caused by machinery, traffic



***LINE-ABREAST LOOP** practised above their North Luffenham (Rutland) base by the aerobatic team of No. 111 Squadron, R.A.F. (Hawker Hunter F.6s). The team demonstrated this new manœuvre at Stavanger last Sunday and comment is made in a leading article. Effective smoke generators are installed in the Avon tailpipes.*

and other factors will have to be minimized. In designing their building at St. Petersburg, Florida, Minneapolis-Honeywell actually had to guard against the vibration caused by the sea breaking against the shore twelve miles away. A main railway line and the Great North Road pass within half a mile of the Stevenage location.

Trident's 79,720ft

SUD-AVIATION claimed on May 2 that a Trident II, piloted by Roger Carpentier, had reached 24,300m (79,720ft). The flight was apparently officially observed and will be put forward as a claim against the figure of 76,828ft recently established by a Grumman Super Tiger.

Local War

IN operations to relieve the besieged fort of Assirir, an R.A.F. Shackleton dropped two sticks of 1,000 lb bombs on a target in a wadi N.W. of Jebel Jihaf. An official communiqué said that the attack took place in bright moonlight, away from inhabited areas. A second Shackleton was unable to identify its target positively and returned without dropping its bomb load.

W.R.E. Extension

IT is reported that the Weapons Research Establishment at Woomera will be extended to permit full-range firing of the British IRBM to take place in 1960. A new facility for the IRBM will be built at Lakehart, 30 miles west of Woomera. The first range-extension will reach the northwest coast of Australia; the second stage will extend to a point 800 miles into the Indian Ocean; and the final stage envisaged is 1,200 miles farther, giving a total range of over 3,200 miles.

Erring Missile No. 2

ON April 30, a test vehicle fired from R.A.E. Aberporth passed out of ground control and, the destructor apparently failing, crashed on waste ground near a housing estate at New Quay, twelve miles away. The vehicle was not publicly identified, apart from being described as experimental and not related to such well-tried devices as Bloodhound, Thunderbird and the G.P.V. On March 6 a more conventional round had fallen within the perimeter of the establishment, causing no damage or casualties.

Aeronautical Samples

TWO new types of Italian helicopter (one of them in model form) were on view at the International Samples Fair held in Milan from April 12 to 27. The one exhibited as a scale model was the Agusta 2-101D, which is to have 27-passenger capacity and will be powered by three Turboméca Turmo III engines; and the other newcomer was the Lualdi L-55, a two-seater powered by a Lycoming O-360.

Agusta had four helicopters on show—a 47G and three versions (five-seater in Ali Linee Italiane livery, four-seater, and ambulance) of the 47J Ranger; and during the Fair the Hiller XROE-1 Rotorcycle was demonstrated. A complete building, called *Primi passi nello spazio* ("First steps in space") was devoted to astronautics; and on their stand the Bristol Aeroplane Co. showed an Orpheus BOr.3 turbojet, a model of the Proteus and scale models of the Britannia, Bloodhound and Type 192 helicopter.

***PUFF FROM BROUGH:** On May 2 the Kaman K-17 cold-cycle pressure-jet helicopter flew for the first time. Intended for military, agricultural and similar "outback" operations, the K-17 is powered by a Blackburn Turmo 600 free-turbine unit driving a Boeing air compressor. In this picture the steering rotor is stationary.*

Hanover Runway Ejection

WATCHED by a number of senior officers of the West German Air Force, Herr R. Bulwinkel made a successful runway-level ejection from a two-seat Meteor at Hanover last Monday. He used a Martin-Baker Mk 3H seat, and the pilot was Capt. J. E. D. Scott.

The demonstration was the first live ejection of its kind in Germany. Other successful runway ejections with Martin-Baker seats had previously been made at Chalgrove, Oxon (September 1955), and Patuxent River, U.S.A. (August 1957).

CL-44D

WHEN the Bristol Orion programme was discontinued the Royal Canadian Air Force chose the Rolls-Royce Tyne for its Canadair CL-44 (CC-106) long-range transport. Canadair have now made an announcement including the following points:—(1). Despite the engine change, the first CL-44D (the new designation) will come off the line late in 1959—to the original schedule. (2). Revision of the Canadair/Bristol agreement to allow Canadair unrestricted choice of market for any type of CL-44 with any powerplant except in the United Kingdom where the aircraft will be restricted to maritime reconnaissance purposes. (3). The following is the specification: span: 142ft 3in; length, 136ft 9in; gross weight, 205,000 lb; cruising speed, 375 m.p.h.; accommodation for up to 150 passengers (1.1c/seat-mile) or 66,500 lb of cargo (5.2c/2,000 lb-mile); maximum range with typical reserves and "substantial" payload, 5,100 miles, or 4,200 miles with maximum passengers or 50,000 lb of freight.

"FLIGHT" NEXT WEEK: A special number, particularly valuable for reference purposes, reviewing current progress in the development of flying aids.

Jets and Acceleration

SOME THOUGHTS ON PRESENT SHORTCOMINGS AND FUTURE PROMISE

MANY readers will recognize the author's initials at the end of this article as those of a distinguished aeronautical engineer and Service test pilot—one as well versed in the handling of modern high-performance aircraft as of World War I veterans.

AFTER a long stage on a dark night through air which had been turbulent and occasionally ice-ridden a pilot was bringing in an airliner with eighty passengers on board. Being tired he was glad of the excellent facilities for homing and night landing which he knew were available at his destination. He was on the last mile of his approach and the runway lights were just visible through the misty drizzle. "It won't be long now," he thought; but as he knew his co-pilot was a bit superstitious he didn't say it out loud. It was at this moment that an urgent order came through from Control telling him to overshoot, because there was an obstruction on the runway on which he was about to land.

The pilot had been approaching rather above the normal glide-path in order to take care of any possible errors, human or technical; but as soon as he was sure of his position by the approach lights he had closed his throttles completely. When he got the order to overshoot his throttles had been closed for six seconds and his jet engines had "run down" almost to their idling speed. His airspeed had also fallen off to just about the right value for the gentle flare-out over the airfield boundary. All conditions were therefore just right for a landing—but not so right for going round again.

Without a moment's delay the pilot pushed all four power levers wide open and, after the few seconds' delay which was quite rightly demanded by the acceleration-control unit, all the engines reached 95 per cent of their full power. The pilot raised the undercarriage, eased up the flaps to the maximum lift position, allowed the speed to build up to 180 knots and climbed smoothly and safely to the airfield circuit height again. The time taken for the engines to achieve 95 per cent of their full power from their near-idling speed had been just about five seconds and the pilot was very glad it hadn't taken any longer. The reason it had taken no longer is a simple one: it is written down in British Civil Airworthiness Requirements that five seconds is the maximum time allowed for the acceleration, although there are one or two alleviations to this rule.

Historically. In the earliest days of piston engines it was a bit of a surprise to experts like Ricardo that the old engines ever accelerated at all, for there were a number of very good reasons theoretically why an economically adjusted engine should have virtually no capacity for acceleration. But Ricardo found that these old engines achieved this apparent phenomenon by the temporary drying-off from the induction pipe walls of the accumulated fuel condensation, after which the increased suction and a larger jet allowed the engine acceleration to proceed. Later on the difficulty of reconciling economical adjustment of the carburation with good acceleration characteristics was resolved by the use of the "accelerator pump" whereby the forward movement of the throttle injected extra fuel into the induction pipe. With the introduction of this device, and a few other refinements, adequate acceleration in piston engines was guaranteed for all normal uses in the air. As a result, pilots based their approach and landing technique on the ordinary characteristics of piston engines.

If those characteristics had remained as bad as they used to be many years ago pilots would never have complained about the relatively sluggish acceleration of jet engines and the designers of those engines would have slept much better at night during the last decade. It is a fact which is worth mentioning here that the acceleration of a jet engine is not really as sluggish as it appears to be in comparison with the piston engine, although it is definitely not as good. What the pilot chiefly appreciates—or fails to appreciate—is the smoothness of the increase in power of the jet engine by comparison with the regular uproar of activity which occurs when one opens the throttles of a piston engine and thereby touches off a series of explosions often rendered more violent by a bit of detonation thrown in. Added to this disturbance a lot of heavy work is done by the variable-pitch motor in the propeller, there is a certain amount of oscillating and nodding by the whole engine and, as a result of this nodding, a bit of gyroscopic jerking by the propeller. However unhelpful all these activities may be towards the main aim they definitely give the pilot a great feeling of confidence in the fact that something is really happening just at a time when he most wants it to happen.

The steady, only slightly delayed, and usually much greater surge of power from the jet engine is nothing like so reassuring in a moment of crisis—it is far too smooth! This brings us to the question of what it is that the pilot really needs in such moments of crisis as that described at the beginning of this article.

The Real Requirement. What the pilot basically requires in an embarrassing moment such as described is quite simple and understandable. He wants, and immediately, enough power from his engines to overcome the drag of his aircraft, drag which at that moment is considerably increased by the fact that the undercarriage is down and the flaps are probably fully extended. With this amount of power he will at least be able to maintain his height and speed. Very soon afterwards he wants enough power from his engines to give his aircraft nearly the same acceleration he normally has on take-off: this need not be the same power he has on take-off for two reasons: firstly, he already has flying speed over the beginning of the runway and therefore he does not have to accelerate from a standstill; secondly, every jet aircraft approaching to land will be at, or below, the maximum landing weight, which will be considerably less than the maximum take-off weight.

It might be thought that the British Civil Airworthiness Requirement quoted at the beginning should have been written in terms of aircraft acceleration instead of in terms of increase in engine power giving an arbitrary time limit of five seconds; but it would obviously be impossible to develop an engine to give a stated acceleration to an unknown aircraft of an unknown weight and an unknown drag. The five-second rule is therefore given because it provides a very satisfactory guide to the engine designer and would normally give the aircraft in which it will finally be installed the required acceleration characteristics. If, due to some freak of aerodynamic or structural development, the engine found itself in an aircraft either twice as heavy or half as heavy as that expected then the rule can be modified or alleviated to take care of the exception.

In any case the rule has to be applied intelligently, as will be appreciated by a glance at Fig. 1, wherein curve A meets the five-second rule adequately but is entirely unsatisfactory from the pilot's point of view, since the work done on the aircraft (as represented by the area under the curve) is negligible. What the engine would have been doing after five seconds might become of

Fig. 1

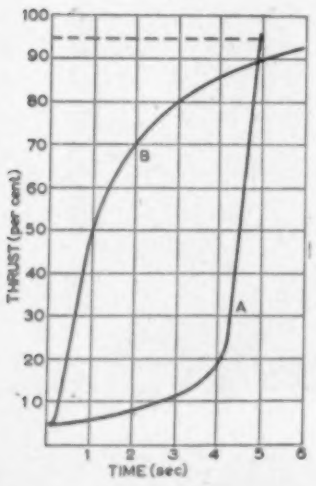


Fig. 2

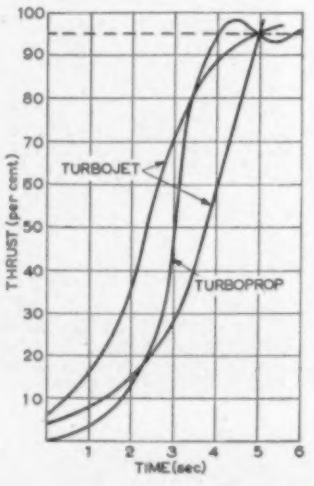
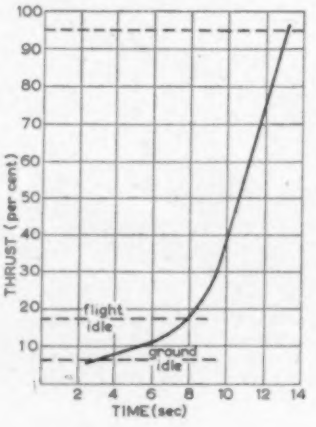


Fig. 3



Jet acceleration curves: Fig. 1, hypothetical; Fig. 2, typical; Fig. 3, ground and flight-idle stops.

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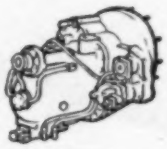
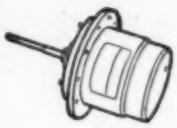
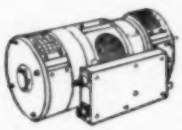


Constant Speed Drives

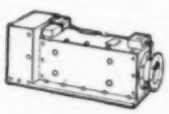


Pump Motors



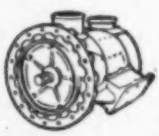
Invertors

Alternators

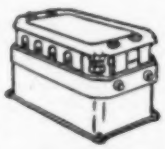


Transformer Rectifier Units

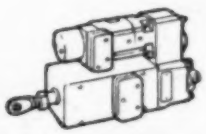
Transformers



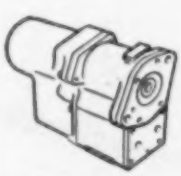
Generators



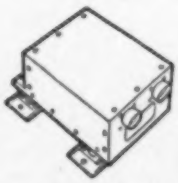
Circuit Breakers



Linear Actuators



Rotary Actuators



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JETS AND ACCELERATION . . .

purely academic interest if the airliner, with eighty passengers, had descended untidily into an obstruction after three. Curve B, on the other hand, is perfectly acceptable to the most slow-thinking pilot but, in fact, it does not meet the five-second rule. In actual fact neither of these curves is representative of the acceleration characteristics of any normal jet engines. Their behaviour lies somewhere between the two but unfortunately tends to have the A shape rather than the B. This is just one of the worries which ensure that our engine designers earn their pay.

A few, more typical, curve shapes for jet engines are shown in Fig. 2.

Providing the Required Acceleration. If the engine designers were not the serious-minded and conscientious sort of fellows they generally are they could find out what their own engine characteristics were and draw them out, the curves would appear approximately as in Fig 3. They would then count back on the time scale from 95 per cent of full thrust for five seconds and there insert a flight-idle stop to ensure that the pilot could not close his throttle beyond that point. He might also insert a "ground-idle" stop further back for use on the ground where things don't happen so quickly. Having done this he might relax; but he wouldn't get away with it for long. Very soon he would be inundated with complaints from operators whose economics had been upset by a few important "lurkeys" which the designer had either overlooked or despised.

It might happen that the flight-idle position as set by counting back gave a residual thrust which was quite unacceptable by the operator because it was too high. The aircraft, unless impossibly overflapped, would have an embarrassingly flat gliding angle and a long float before touch-down. If the ground-idle position also gave a relatively high residual thrust the landing run would be abnormally long and the wear and tear on brakes during landing and taxying would be unacceptable. There would also be a wasteful expenditure of fuel during all running periods on the ground. Just counting back five seconds will probably not give the complete answer. It will be necessary to adjust the fuel input characteristics to ensure a reasonably rapid engine acceleration from a low idling thrust without the engine surging. The surge line, incidentally, is always lurking unpleasantly close during rapid engine accelerations and it is essential to have some form of acceleration control to see that it doesn't get too close. Acceleration control does not necessarily have to be effected by a separate gadget; it can be designed into the fuel delivery system.

All jet engines have this acceleration problem in greater or less degree. Basically it derives from the need to speed up the rotation of a piece of metal with a high moment of inertia before the full fuel flow can be accepted by the engine. For this reason the increase of thrust must always lag behind the increase of engine speed, because a lot of work has to be done on the rotating parts of the engine before it can do much in accelerating the aircraft. Some types of engines, such as the single-shaft and twin-spool turboprops, start off with an advantage by being able to keep the speed of their rotating parts high under idling-thrust conditions; but they still have to speed up their rotating parts a certain amount, and the airflow through the engine very considerably, before they get near their full thrust.

Engine designers have now gone a long way towards supplying what the pilot needs, and, almost of equal importance, avoiding what the designer of wheels and brakes dislikes. There are still improvements which the engine designer can achieve by more sophisticated methods of metering-in the fuel during accelerations. The pilot needs all the acceleration he can be given from idling thrust; the designer of wheels and brakes has his job made much harder if, in getting full power quickly, the engine has to start off from half-way there by retaining a large proportion of thrust when it is supposed to be giving none or, at least, only negligible thrust.

For taxying it is advisable and certainly economical if the engines under idling conditions give insufficient thrust to keep the aircraft rolling on a level, hard, concrete surface. If this can be managed it is possible to taxy out to the take-off point using only nosewheel steering and without ever having to use the brakes.

For landing it is clearly advisable to have as little residual thrust as possible, because every pound of it has, ultimately, to be counteracted by the brakes except when reverse thrust is provided. One may hope that this will soon become general.

Reverse Thrust. Although reverse thrust would seem to be the final answer to many of our worries it will bring a few additional headaches to the engine designers apart from the obvious ones connected with the mechanical complications of providing it. First of all, when it is needed it may be needed in a hurry; so engine acceleration will be of comparable importance in the reverse thrust case as in the overshoot case. At present most designs for thrust reversal are operated by the throttle coming back through the throttle closed, no-thrust, position: one can imagine a situation involving a landing on a short runway with slightly obstructed approaches, when the technique would be to drag the aircraft in, fully flapped and with nearly full power, over the obstructions and then touch down and demand reverse thrust immediately. Only the engine designers know (and some of them may not know yet), what happens when the engine is pulled from full forward thrust into full reverse thrust, all in a matter of seconds. What we do know is that jet engines probably feel sudden decelerations just as much as they feel sudden accelerations. The reason is that the blades don't like being suddenly quenched any more than they like being suddenly scorched. The difference in temperature thus induced between the blade skin and its inside can start fatigue cracks either way through thermal shock. It is even possible that the stress can be greater in the quenching case during a sudden deceleration.

There seems to be no reason from the engine's point of view why it should not be "flicked" straight from full forward thrust into full reverse without passing through the throttle-closed position. This would eliminate the sudden changes of temperature around the turbine blades. It would, of course, be a bit of a shock to the passengers if some emergency demanded such a manœuvre; but it would be of small magnitude compared to the shock they would experience if their airliner arrived at the end of the runway still doing eighty knots.

Although the full facility of quick reverse-thrust may not often be demanded it may still be needed on occasions. The facility should therefore be allowed for. It would be an additional safety measure. A piston engine of necessity has to pass through idling power on its way to reverse thrust for fear of over-speeding. Its normal characteristic therefore ensured a smooth and relatively quick reversal. A lot of thought will have to be given to the same operation with jet engines if the great possibilities of increased safety thus offered are to be fully exploited.

For approach conditions many jet engines today can get down to four or five per cent of the take-off thrust, which allows for a reasonably steep approach angle; but even this compares badly with the piston engine, with its enormous propeller windmilling round in fine pitch and providing a drag which alone, without the use of flaps, brought an aircraft down at an almost frightening angle of descent. Although no one normally wanted to descend at such an angle, the available drag could be a very present help in time of trouble.

In conclusion, therefore, we look for the day when jet engines of all types use virtually no fuel and give no thrust when we want them to idle, but are still able to give us full power instantly, from no power, when we want it either in forward or reverse thrust. When that happy day arrives an approach in bad weather and a landing on an icy runway will have been made much safer and much easier; the weight of fuel to be carried on any journey will be appreciably reduced; and the wear and tear on brakes will be almost eliminated, because they will have to be used only for emergencies, for parking, and for a few rare occasions when taxying down a gradient.

Nothing which has been said in this article should be taken to imply that we are in such a hurry to get a reverse-thrust system that we are prepared to have a "half-baked" one which might go into operation unexpectedly when it is not wanted. A.H.W.

VIPEROUS GOOSE

DURING the annual general meeting of the Fairchild Engine and Airplane Corporation it was announced that experimental batches of the company's Bull Goose missiles have been powered by Armstrong Siddeley Viper turbojets. The Bull Goose is a long-range multi-purpose missile, intended chiefly for diversionary functions and bearing the U.S. Air Force designation SM-73 (strategic missile).

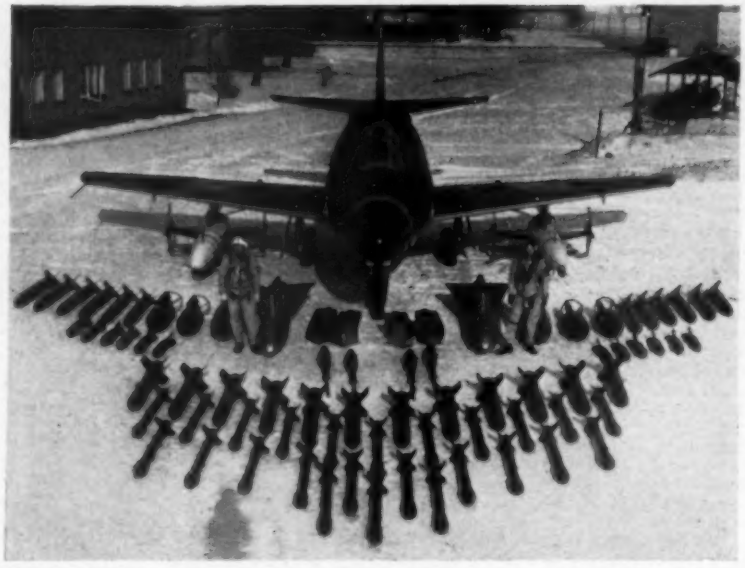
Constructed almost entirely of dielectric materials, it has been very thoroughly tested in sled and rig experiments, and flight trials of the Viper-powered XSM-73s have been outstandingly successful. Fairchild's own J83 turbojet is scheduled for the production SM-73.

INDIAN DEFENCE

SPEAKING in a debate in the House of People at New Delhi recently, the Indian Defence Minister, Mr. V. K. Krishna Menon, announced that the I.A.F.'s Hunter 56s had "special equipment and improvements." He stated that the French Mystère 4 fighters which had been bought were the latest available in production, and went on to announce that the programme to manufacture the Folland Gnat and its Bristol Orpheus engine was proceeding on schedule.

India, he said, was making progress towards self-sufficiency in the production of ammunition and ordnance equipment and hoped to reduce imports considerably this year. The House approved a defence budget of £209m, an increase of about £9m.

HERE AND THERE



LANCEHEADS: Displayed with this Saab 32A (A-32A) Lansen (one S.F.A.-built Rolls-Royce Avon with afterburner) are the following stores: front, 24 × 15 cm rockets and 12 × 18 cm rockets; middle row, six 50 kg bombs, the four 20 mm guns and six more 50 kg bombs; back row, six 100 kg flash bombs, two 250 kg bombs, a 500 kg bomb, a drop-tank (or napalm), the four 20 mm ammunition boxes, and the previous stores in reverse order; mounted on the Lansen are two Type 304 air-to-surface missiles.

Sylt Affiliation

FIRST West German Air Force unit to train with the Royal Air Force—an F-84F squadron—is due to go to R.A.F. Sylt next Monday (May 12) to practise battle tactics and air gunnery.

R.A.F. Recruiting Up

THE number of men enlisting in the R.A.F. during March on engagements ranging from three to nine years was 1,054. This was 418 above the average for the previous 12 weeks and the best monthly total since March last year.

Kolibrie in Germany

AN agreement has been concluded between Nederlanse Helicopter Industrie and the Dornier Aircraft Company under which the latter will market the Kolibrie helicopter in Germany. The Kolibrie now has a full C. of A. and is the first ramjet-propelled aircraft to achieve this distinction.

Wind Tunnel Power

THE Canadian Department of National Defence has placed an order valued at over £140,000 with the General Electric Co., Ltd., for a motor-driven centrifugal compressor for a new wind tunnel at the National Aeronautical Establishment, Ottawa. The plant will have an air output of 40.3 lb/sec at 300 lb/sq in.

International Congress

SCIENTISTS representing 18 nations are to give papers at the first International Congress of the Aeronautical Sciences, which is being held at Madrid from September 8 to 13 and has been organized by the International Council of the Aeronautical Sciences. The initial Daniel and Florence Guggenheim International Memorial Lecture will be delivered by Dr. Theodore von Kármán, chairman of AGARD and ICAS honorary president.

"Treble One" at Hucknall

THE aerobatic Hunters of No. 111 Sqn. are to take part in the R.A.F.A. Eastern Area Air Display at Hucknall Aerodrome, Notts, on Whit Monday (May 26).

Successful Italian Tyres

NEW types of tyres for F-84F, RF-84F and C-119, made by the Italian Pirelli company, have successfully passed dynamic tests at the French test establishment at Toulouse. All NATO specifications, including that for landings at 200 m.p.h., are reported to have been met.

New Cars Assessed

THIRTY-THREE cars, British, American and Continental, over a range of types varying from the Standard Ensign to the 190SL Mercedes-Benz, are dealt with in *The Autocar Road Tests 1958*, a selected compilation from reports which have appeared in our associated journal during the past year. Of real use to the prospective buyer, and of interest to every student of car design and performance, this new publication (of 128 large and well illustrated pages) is obtainable at 7s 6d from booksellers or (by post, 8s 6d.) from Iliffe and Sons, Ltd., Dorset House, London, S.E.1.

"It gives me great pleasure to name this air ambulance . . ."

Minister Looks On

THE Minister of Defence, Mr. Duncan Sandys, visited R.A.F. Abingdon on April 25 and watched parachute training in progress.

M.E.R.L. Open Days

OPEN days are to be held at the Mechanical Engineering Research Laboratory, East Kilbride, Glasgow, on June 4 and 5. Representatives of any organization with engineering interests will be welcome; and applications for invitations, stating the day preferred, should be sent to the Director.

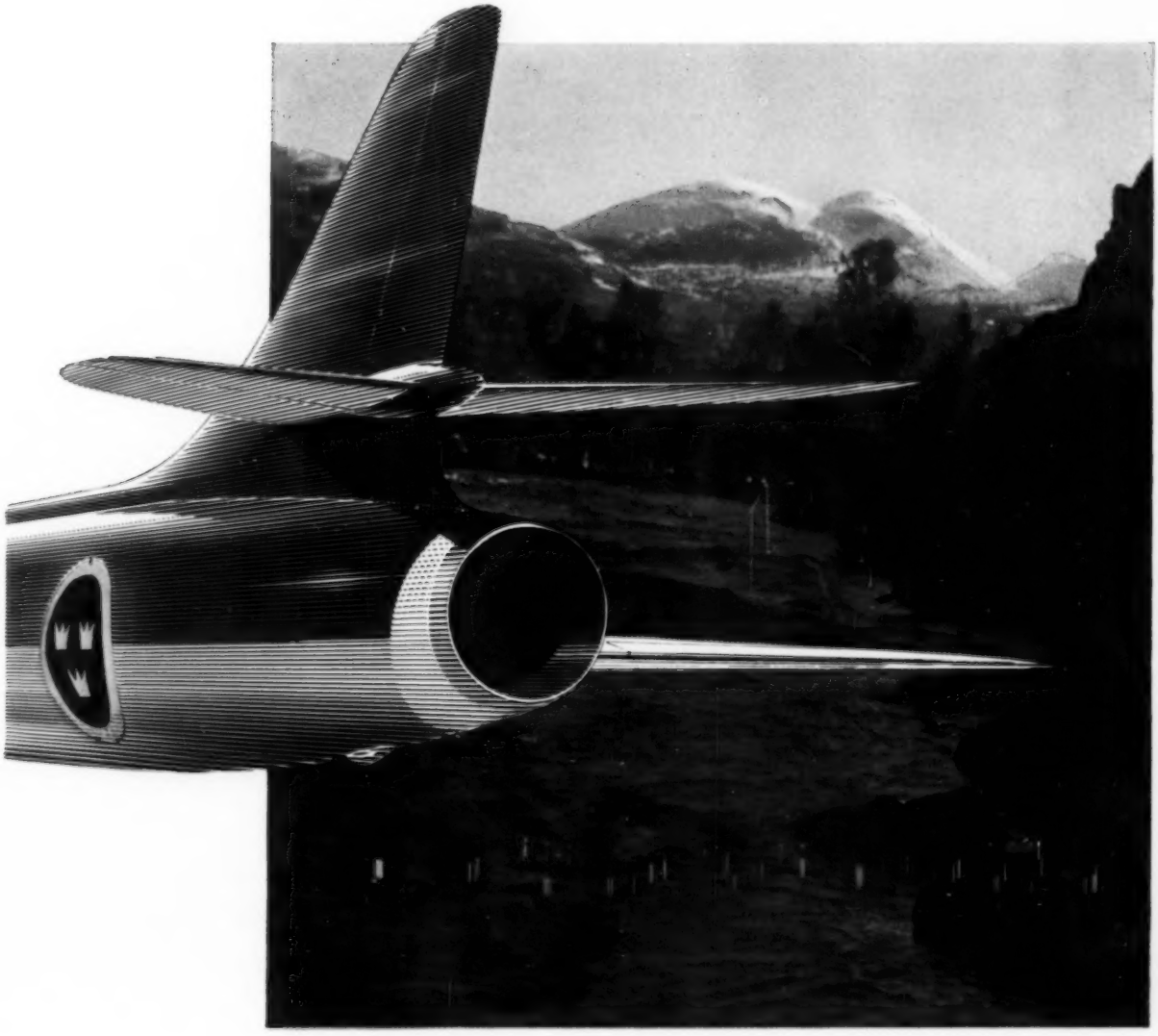
Cossor German Order

AN order has been placed by the Federal German Ministry of Defence with Cossor Radar and Electronics, Ltd., for a complete mobile C.R.21 radar installation. This follows a recent demonstration of the equipment in Bonn and makes Germany the sixth country to have ordered C.R.21 equipment.

INVISIBLE EXPORTS: A new picture of a Dornier Do 27 reconnaissance and liaison aircraft of the West German Air Force—equipped with a comprehensive range of Smiths cockpit instruments.

Hunters Defend SWEDEN

Speed, offensive power and great versatility have given the Hawker Hunter pride of place in many air forces of the free world, including that of Sweden. Today several squadrons of Hunters are in service with the Swedish air force, forging another sturdy link in the defences of Western Europe.
Hunters are also in service in India, Denmark, Holland, Belgium, Peru, Iraq — and now Switzerland.



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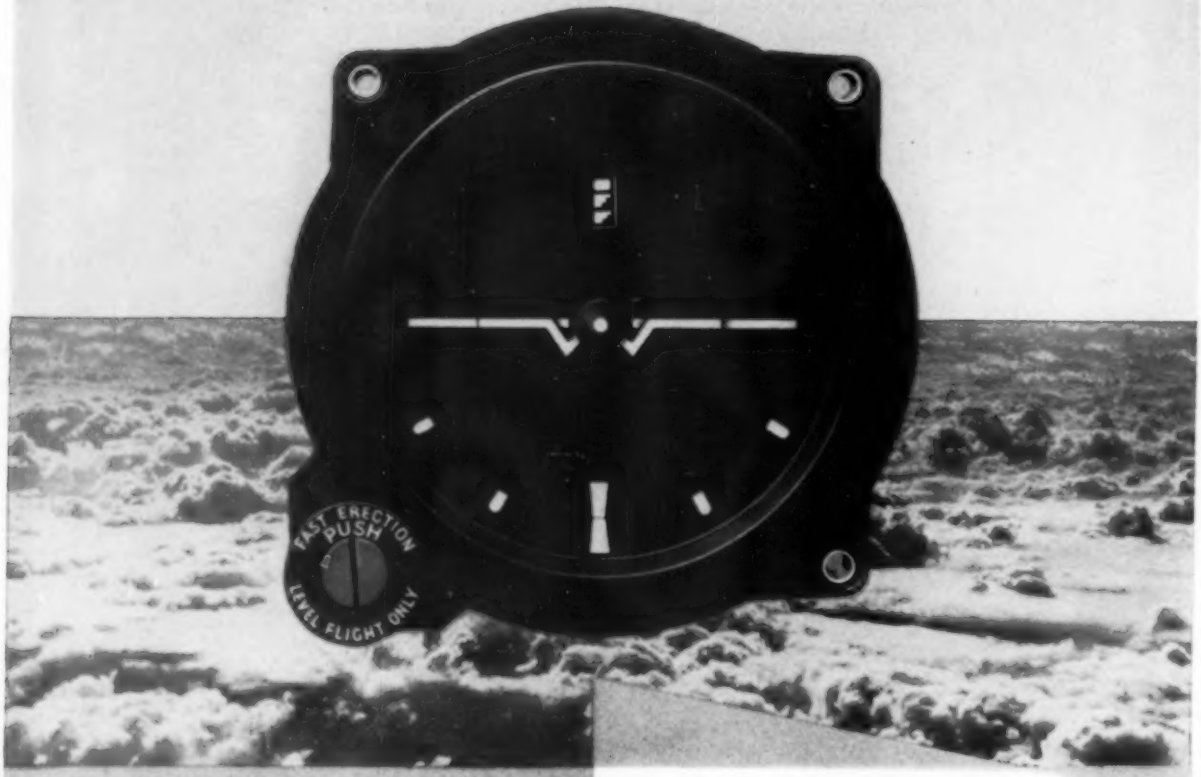

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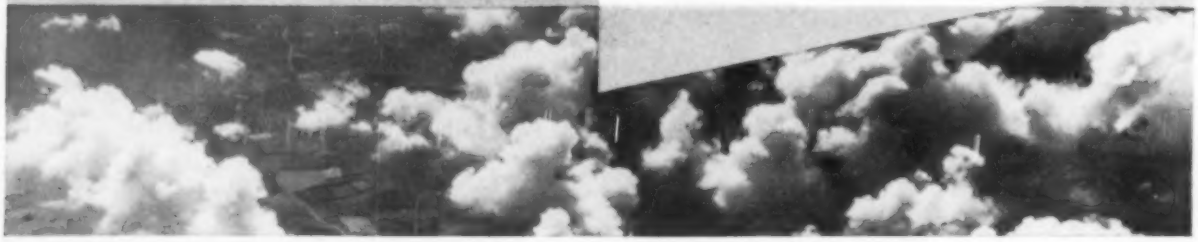

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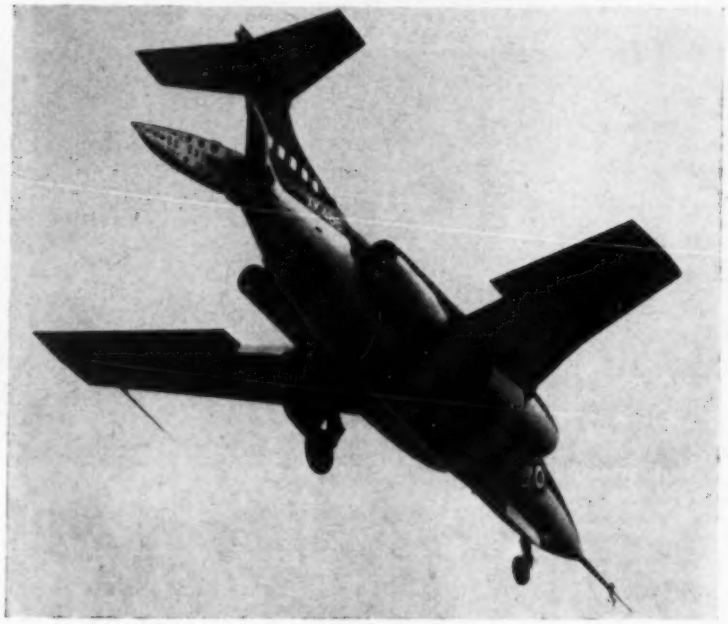


NA.39

Blackburn's Naval Bomber: A First Analytical Study

By THE TECHNICAL EDITOR

The first NA.39 coming in to land after its 39-minute flight at the R.A.E. Bedford, on April 30. The photograph gives an excellent indication of the geometry of the aerodynamic surfaces and airbrakes. Finish of the aircraft is a glossy "roundel blue" and white.

FOR more than forty years, Blackburn and General Aircraft, Ltd. (originally Blackburn Aircraft), of Brough, East Yorkshire, have been one of the principal suppliers of aeroplanes to the Royal Navy. Their historic lineage of carrier-based types temporarily came to an end when the Firebrand went out of production in 1949 and was replaced by the gargantuan Beverley transport for the R.A.F. Now, however, Blackburn are firmly back at their old trade, with a remarkable machine which bears the Admiralty specification number NA.39.

The emergence of a completely new type of British military aeroplane is today an event of real consequence, since—unfortunately—it is perforce born into a climate of opinion which tends to regard piloted weapon systems as remnants of a bygone age. Although such a contention cannot withstand even cursory examination, it is nevertheless a fact that, now that the NA.39 has flown, not a single type of British combat aeroplane for which an order has been placed remains on the drawing boards or in the experimental departments of any British company. The Blackburn aeroplane is, therefore, worth as detailed an appraisal as security will permit at this stage.

It must be admitted that superficial examination of the new machine could lead a lay observer to wonder what it has got that the others haven't. It looks, in fact, much like a Scimitar which has been subjected to the attentions of an area-ruling maniac. But the Government has assigned a substantial proportion of its hard-pressed financial strength to the design and construction of this aeroplane, and this alone must reassure the onlooker that the NA.39 is, in fact, a remarkable aircraft, with capabilities unmatched by anything else either flying or in prospect. To find out why this is so, one has to probe beneath the NA.39's tough hide, and apply a great deal of the Sherlock Holmes practice of observation and deduction.

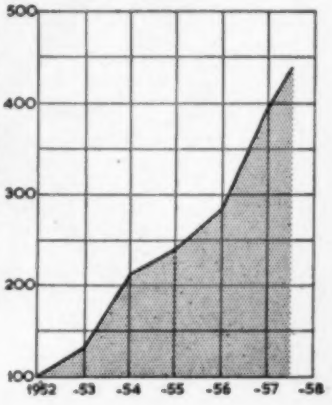
Perhaps the starting point should be the specification itself. Publication of any part of the NA.39 specification is obviously prohibited, but certain facts can reasonably be assumed. Among these are the following: the ability to operate from ships such as *Victorious*, *Eagle* and *Ark Royal*; provision for a crew of two, and sufficient equipment to make possible all-weather operation; ability to carry, both internally and externally, the greatest possible range of stores, including a variety of nuclear weapons; the maximum possible range, the radius of action being at least 500 nautical miles; a fair all-round performance, including a cruising speed of over Mach 0.9; and a structure suitable for operation at high indicated airspeeds, so that "under-the-radar" attacks can be made from exceedingly low altitude. Most of these logical requirements pose no more than minor engineering problems; but three of them are critical and must have demanded every ounce of effort and ingenuity from the Blackburn design team. These requirements are the intimately related ones of range, low-altitude (including take-off and landing) performance and structural stiffness.

It seems likely that the specification was formulated about three years ago. The requirement was put out to tender, and the resulting competition was undoubtedly exceedingly keen among the numerous firms who submitted proposals. Eventually Blackburn were awarded the contract. The chairman of the company, then the late Robert Blackburn, said in his annual address in July 1955, "I am very happy to be able to inform you that an important and challenging aircraft development contract, for which a number of other major firms in the industry competed, is being placed with your company." It is logical to suppose that this contract must have covered the construction of a sizeable batch of development aircraft; the choice of twenty in the case of the P.1 programme may, perhaps, be a guide in this respect.

Anticipating their success, Blackburn rapidly expanded their resources, and augmented their technical strength to meet the enormous challenge posed by this difficult aeroplane. Actually, as an accompanying graph shows, the company's technical staff has been increasing steadily since N. E. Rowe became technical director six years ago. The following year Barry Laight was appointed chief designer (aircraft), and in 1954 Bert Smith came to head the aerodynamics department, a particularly important one at that time. In that year, as the graph shows, the build-up of staff was rapid, particularly in the fields of electrics and structures. Roy Boot became deputy head of aerodynamics, and Harold Brumby was appointed project designer for the aircraft itself.

Blackburn are not a particularly large aircraft company, even by European standards, and several of the competing designs in the NA.39 contest must have come from companies with much greater technical staffs and equipment. The placing of the contract at Brough must have been due simply to the superiority of the design submitted, with which Blackburn must also have given an earnest of their intention to strengthen their ability to "engineer" and manufacture such a machine. In the event, they have not only done this but they have also produced the hardware ahead of a very competitive schedule—and very much sooner than many people believed possible. (In passing, it is also worth noting that every production Beverley has also come off the line on schedule.)

To a considerable degree, the basic size and shape of a machine designed to such a specification is settled before it has begun. Even *Victorious*, the most modern of our carriers, imposes fairly stringent limits on the type of aeroplane which can be operated from her deck. In the beginning, therefore, the factors determining gross weight are the strength of a carrier deck, the performance of the present steam catapult and the wire arresting system. Of these,



Growth of Blackburn technical staff since 1952; the increase is depicted on a percentage basis, as actual figures are secret.

NA.39 . . .

deck reaction is probably the most important. In addition, the dynamic and mechanical properties of hooks meeting wires combine with the permissible run-out along the deck to limit the landing speed, and the two factors together give the designer a fairly clear indication of the wing area which he will need for a given section profile or maximum lift coefficient. In practice, as will presently be shown, lift coefficient and wing section are by no means as inter-related as they once were, for boundary-layer control, which is undoubtedly used in the Blackburn aeroplane, can increase the available lift by as much as 100 per cent under certain conditions.

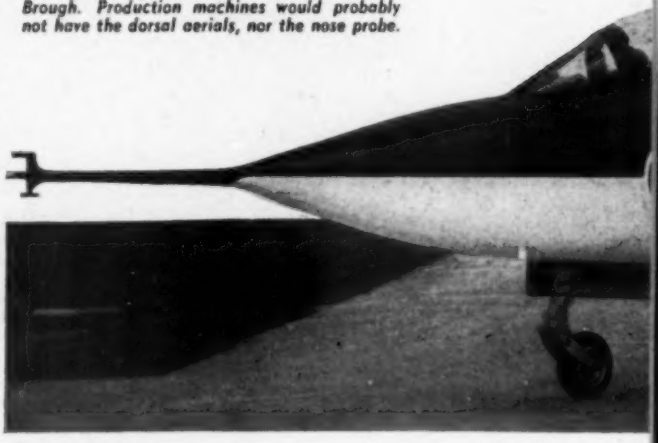
It has many times been suggested that designing an aircraft to fly supersonically (at any altitude) either doubles its weight or halves its range. This is a sweeping approximation, but it serves to show that the penalties of going beyond—especially *just* beyond—the speed bracket which has become known as "high subsonic" incurs substantial penalties. The three big variables confronting the team at Brough were therefore speed, range and structural strength. It is extremely interesting to compare the Blackburn machine with its counterparts in the U.S. Navy.

The new tactical strike machine for American carriers is the Grumman A2F, which is relatively small and conventional. For "big league" operations, however, the North American A3J-1, the first example of which is almost complete at Columbus, shows the way American thought has progressed. Powered by a pair of rear-mounted J79s, with afterburners, the A3J is intended for a high-altitude speed of approximately Mach 2, and for a low-level speed of something over Mach 1. One assumes that North American designed the A3J to a closely defined specification requiring such performance. To the writer it seems curious that the U.S. Navy should have accepted the heavy penalties of such performance, since Mach 2 at height seems much less valuable than Mach 1+ on the deck; it is certainly not fast enough to embarrass a really capable surface-to-air missile. Perhaps the Navy just wanted a bomber that could fly as fast as the Air Force's Hustler.

As a result of its high speed the A3J is a machine of no mean proportions. Had its sponsors concentrated upon the primary mission requirement—supersonic speed at low level—they would certainly have been able to cut the A3J's size and weight and to have reduced its cost by about 50 per cent. Moreover they would not have been presented with a flying machine which, so far as the writer can calculate, can be operated only from a *Forrestal*-class carrier or from a shore base. In contrast, the Fleet Air Arm—possibly because they had no choice—have elected to buy an aeroplane tailored to the dictates of the low-level mission and not intended for the Mach 2 high-level type of sortie.

One has only to glance at the NA.39 to appreciate that it is not built for Mach numbers much beyond unity. Yet it is designed specifically to do the low-level mission, and this it can probably achieve as well as any other machine, not even excepting the fearsome A3J. Moreover, it may well represent a new class of relatively cheap and versatile strike aeroplane capable of fulfilling many mission requirements of both navies and land-based air forces.

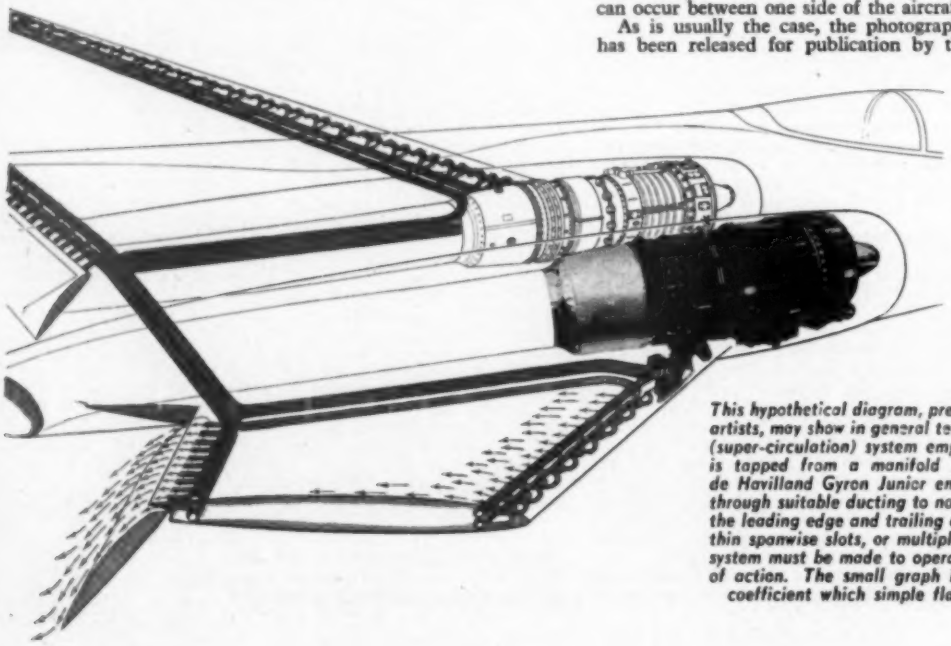
This photograph of the first NA.39 was taken some weeks ago at the Blackburn airfield at Brough. Production machines would probably not have the dorsal aerials, nor the nose probe.

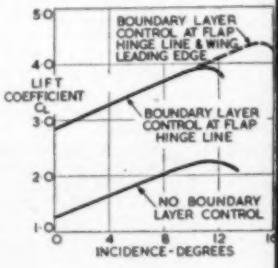


In fact it is fairly evidently Blackburn's bid to produce the optimum tactical strike aeroplane. That it is area ruled has already been stated in positive terms (in fact its coarse application leads one to wonder whether or not the area ruling came after the basic design was laid down). The area rule is of the transonic variety—of which more anon—and the design cruising speed is likely to lie in the "high subsonic" Mach range between 0.95 and 1. Without area rule the cruising speed would almost certainly be well below 0.9. In addition, the manœuvrability would be reduced and in all probability the crew would be subjected to a rougher ride. The latter is a factor of great importance when operating at low level, and one which can prevent a strike machine from making use of its full performance envelope. The fact that the NA.39 can fly faster than sound would seem to be an incidental by-product of its other characteristics, and not a design requirement.

Yet the obvious requirement of designing for full e.a.s. robs the aircraft of the advantages in lightness which subsonic cruise would otherwise confer. In fact, the development of a producible airframe which can operate at a speed of the order of Mach 1 at sea level is one of the most difficult tasks with which a designer can be confronted. In either the subsonic or the supersonic regimes it is possible to know the position of the centre of pressure and to obtain a clear idea of the airflow around the whole aircraft, but in-between conditions change drastically and rapidly. Divergent flutter must be avoided at all costs, and this alone demands a structure of immense stiffness and a completely irreversible control system; for example, the aerodynamic loads can give rise to severe torque stress in the main wing box and differential loading can occur between one side of the aircraft and the other.

As is usually the case, the photograph of the aircraft which has been released for publication by the Ministry of Supply





This hypothetical diagram, prepared by one of "Flight's" artists, may show in general terms the sort of air-blowing (super-circulation) system employed in the NA.39. Air is tapped from a manifold surrounding each of the de Havilland Gyron Junior engines and is then passed through suitable ducting to nozzles above the wing near the leading edge and trailing edge. The nozzles may be thin spanwise slots, or multiple fishtails as shown. The system must be made to operate with either engine out of action. The small graph indicates the gain in lift coefficient which simple flap-blowing can achieve.

gives practically no indication of the planform of the wing. However, numerous unofficial photographs, taken during the NA.39's first flight, reveal a broad-chord wing with appreciable sweep and generous area. It is probable that its thickness/chord ratio is less than that of the Supermarine Scimitar since the design Mach number ought to be somewhat higher. Moreover, the high manœuvrability required for low-level attacks and toss-bombing implies a design factor of at least 8 and perhaps 12, from which it can be concluded that the mainplanes are extremely strongly built with multiple spars and thick skins, possibly incorporating integral stiffening. In his first annual report, written in July 1956, Blackburn's present chairman, Mr. Eric Turner, said, "We are also going forward with the latest developments in integral construction, in which the structure is largely machined from the solid. . . ." Last August our sister journal *Aircraft Production* published an extensive article on this work, which probably related to the wing of the NA.39.

Although no details of this are apparent from the photographs, the wing is clearly fitted with devices giving the maximum possible lift coefficient. It is certain that the incidence of the wing itself is fixed, but, supplementing high-lift flaps, the leading edges may perhaps be hinged, or otherwise movable, to increase the effective camber at low speeds. The Scimitar has a simple hinged leading edge of the droop-snoot type. So also does the American Crusader, whereas such machines as the Skyhawk, Fury and Tiger have large leading-edge slats. A slat deals with a relatively large volume of air at a relatively low velocity, and represents boundary-layer control in its longest-established form.

Boundary-layer thickness increases with linear distance (across a chord or along the fuselage, for example) and also with velocity, so that the whole aircraft tends to be surrounded by a turbulent envelope of "tired" air; moreover this boundary layer may break away from the skin, causing separated flow, high drag and reduced lift. It is highly doubtful that Blackburn have worried about the boundary layer over the fuselage, since attention to this can only reduce drag and is of economic interest only in the field of "global" laminar-flow transports of the type envisaged by Handley Page. The boundary layer over the wing, and perhaps over the tail also, is a different story, and it is worth while controlling it in order to reduce drag and increase lift, particularly to improve performance at the bottom end of the speed range. The aim is generally either to suck the boundary layer away, through slots or perforations, into the interior of the wing and thence to a discharge outlet (as Handley Page have done) or to inject energy by some means to increase the momentum of the boundary-layer sheet itself. This energy can be supplied by small vanes of the type frequently referred to as turbulators or vortex-generators, but these impose a measurable drag penalty. Alternatively, the tired air can be helped along to the trailing edge by injecting into it a high-velocity —possibly sonic—stream of air from spanwise slots. Such a slot can be placed close to the leading edge on the upper surface, where it will have the same effect as a slat, but will deal with a smaller volume of air at higher velocity.

In addition, or as an alternative, compressed air can be ejected from a thin slot above the leading edge of each flap. This is doubly valuable in that it helps to preserve the flow over the flap when the latter is depressed, so that the lift coefficient, as well as the drag, is greatly increased (unlike a conventional flap which usually stalls at full deflection). It is well known that the Scimitar has "blown" flaps of this type, and in our issue of April 4 an article on the Scimitar commented "air is bled from a late compressor stage of each engine and ejected from a supersonic nozzle to give boundary-layer control over the trailing-edge flaps. The supply pipes from each engine are interconnected so that there is no adverse effect if an engine fails." It may be noted that the blown flaps of both the Scimitar and NA.39 are comparatively small, and if such a system is employed in the NA.39 it may well extend across the greater part of the span. An accompanying diagram shows the sort of basic layout which may have been adopted, and a graph indicates the gains in lift coefficient which are possible.

It is perhaps appropriate at this point to turn to the question of propulsion, since in an aircraft like the NA.39 the lift, drag and thrust are intimately related by the joint thermodynamics of the powerplant and boundary-layer control system. From the outset, Blackburn chose the de Havilland Gyron Junior turbojet, two of which are fitted at the roots of the wings. The only thrust which may be officially published for a Junior is 7,000 lb (DGJ.1) although later versions, such as the DGJ.10, are known to have different—and probably higher—ratings. It follows that the propulsion system of the NA.39 has characteristics which differ appreciably from those of the other naval twins; the total installed weight must be much less and the fuel required for a given range is probably somewhat lower.

Each Gyron Junior is apparently mounted right at the forward end of its nacelle, being slung from two of the fuselage frames and fed with air from a direct pitot intake (a further indication that the Mach number is not intended to reach much beyond unity). The cowling panels are clearly well forward of the strong torsion box of the wing, which is probably attached to frames around the jet pipes. The latter are undoubtedly long, but their modest diameter should minimize drag and weight. At their rear ends the pipes are toed outwards, partly to reduce asymmetric yawing moments but chiefly, no doubt, to prevent Coanda adhesion and damage to the rear fuselage due to ultrasonic buffeting. Afterburning (reheat) is clearly not fitted, since in a machine like the NA.39 range is of far greater importance than speed. Each engine bay is equipped with a Graviner fire-protection system, which was fully proved during trials with a full-scale rig in which every flight condition could be simulated.

Inboard, adjacent to the fuselage wall, is a small subsidiary intake which must swallow some of the boundary layer and may serve other functions. Outboard of the powerplants are additional intakes, of surprisingly large size, which probably entrain ram-air for ventilating the engine bays and cooling the jet-pipe tunnels and accessories, and possibly for feeding fresh air to the cockpit-conditioning system.

The following text has been issued by Plannair, Ltd.: "In the Blackburn NA.39, Plannair were required to provide cooling for a generator at an operational altitude where air is much thinner than at ground level. The designers faced the problem of designing equipment capable of building up the very high pressure and large volume of air required for efficient cooling, whilst remaining within the strict size and weight limits specified by Blackburn and General Aircraft.

"The outcome of an extensive development programme carried out by Plannair, Ltd., was a multi-stage compressor capable of moving 270 cu ft/min of cooling air; an outstandingly high performance for equipment 12in long by 6in diameter, weighing only 15 lb. Interesting design features of the 14,000 r.p.m. compressor are its built-in gearbox (ratio 2:3) driven by a splined shaft from the main engine gearbox, and the four impellers and four stators used to produce the high pressure rise."

NA.39 . . .

One of the most striking features of the NA.39 is its empennage. Tail design for an aeroplane of this nature poses some of the most intractable problems, and the final answer can only be a distinct compromise. Factors militating against a high-mounted tailplane are numerous, the most important being the fact that it is very difficult to avoid buffeting from the turbulent wing wake at high angles of attack. Moreover, unless great care is taken to avoid excessive tip-stalling at both low and high speed, the flow over a highly swept wing generally has excessive downwash near the roots, and this could further result in undesirable characteristics at minimum speed or extreme altitude. In addition, of course, there is the obvious aerolastic problem of flutter, which can only be cured by careful engineering.

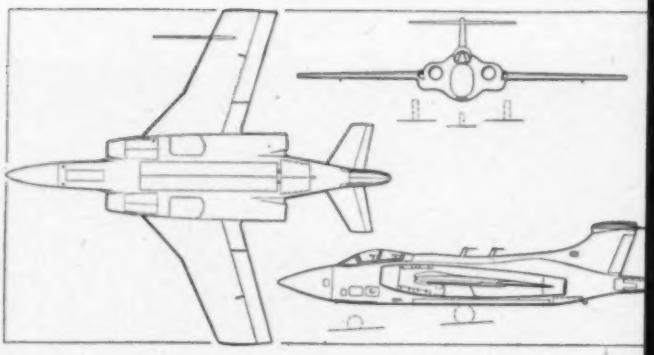
In favour of the high tail is the fact that it acts as an end-plate which increases the effectiveness of the vertical surface, so that the complete tail unit possibly has minimum weight and drag. The high location also takes the horizontal tail well away from the propulsive jets, and from the startling flow pattern which must result when the airbrakes are opened (of which more anon). In addition, the height places the tailplane well clear of the deck or airfield, which can be a major advantage. It may be noted that the tailplane is of the all-moving variety and that it is attached rigidly to the upper part of the fin. The latter is pivoted somewhere aft of mid-chord, the fore part disappearing inside the fixed fin, which consequently has a kinked leading edge. The resulting geometry is not beauteous, but undoubtedly the optimum one for the job.

As previously noted, the controls of a modern low-level strike aeroplane must be fully powered and completely irreversible. The setting of each movable surface must be capable of being controlled to within a small fraction of a degree; backlash must be reduced virtually to zero, and the surfaces themselves must be extremely stiff. The rudder is fairly small, has a skin on either side, a sharp trailing edge and no tab. The ailerons are also sharp-edged and their great size suggests that they droop at slow speeds to act as plain flaps; in fact, it is likely that they are, like the flaps, blown by high-velocity air jets to increase their effectiveness right down to the stall. Of primary importance, however, is control in the pitching plane.

Very few aeroplanes can be manœuvred at an e.a.s. of 600 knots, but this is the sort of thing which the Blackburn machine must be intended to accomplish. Sonic flight through dense air can be controlled by surface movements so small as to be almost imperceptible; control movements similar to those employed in subsonic aircraft, or in supersonic machines at extreme altitude, would not only give the NA.39 pilot unbearable discomfort but could actually break the machine into pieces. On the other hand, carrier operations demand positive control at low speeds, and this in turn calls for a big and powerful horizontal tail capable of making coarse movements. That variable gearing of some kind is incorporated is self-evident, although there are so many alternative systems available that little purpose would be served by suggesting possible solutions. One point which may be mentioned is that, in the transonic regime, elevator loads are almost impossible to predict, and in any case the efficiency of such a surface, working as it does behind or surrounded by shock waves, falls to some 30 per cent of the subsonic value, even if the surface does not decide to flutter. It seems logical, therefore, for the Blackburn machine to have a slab tail. If an elevator is fitted—and the heading photograph (p. 627) suggests that one is—it is merely unlocked by the action of selecting "undercarriage down," or as a separate action at low speeds, in order to provide trimming control at the bottom end of the speed range. This sort of system is employed on the Sea Vixen.

Earlier it was commented that, should a pilot attempt to alight on a carrier at a speed greater than about 130 knots, his hook will merely take a piece out of the arrester wire which it picks up. At present this imposes an upper limit on approach speed. Moreover, the pilot must manœuvre, sometimes quite sharply, according to the indications given him by the mirror sight, and his approach airspeed must therefore be at least 30 per cent greater than that corresponding to the stalling angle of attack at 1g. With boundary-layer control, the additional lift generated from engine power can probably be used to relax these restrictions and allow the pilot to approach at something like $V_{S1}+10$ per cent. This, however, implies maximum "blow" from the powerplants, which in turn demands high r.p.m. and consequently, unless some form of thrust-spoiler or reverser is fitted, considerable forward thrust. It follows, therefore, that the aircraft must have exceptional control over its drag at any given low airspeed, in the form of very effective airbrakes, and perhaps by other means. Thus the aircraft can be brought in at very high thrust with the blown flaps in full operation, while still retaining appreciable power of manœuvre at a speed close to the stall, perhaps, as already noted, by using blown ailerons.

It is worth commenting at this point that the approach speed for an aeroplane like the NA.39 may be considerably less than the minimum-drag speed. In the clean condition V_{MD} might be 170 or 180 knots, whereas in the maximum-drag (airbrakes out) condition this figure might be reduced by 40 per cent or even more. The consequence would naturally be that, as the aircraft would be flying "round the corner" of the minimum-drag curve, speed reductions obtained by pulling the nose up could be maintained only by increased throttle openings. This condition might not be tolerated on an operational type, but how Blackburn have overcome the problem, if in fact it has existed for them, is something one cannot deduce. It seems a fair assumption that blowing reduces the rate of increase of drag as speed is reduced below V_{MD}.



"Flight" provisional drawing.

In the NA.39, Blackburn have resorted to an airbrake geometry which, although logical and extremely effective, has been used very rarely since the configuration was pioneered by Dornier in 1941. As far as can be ascertained, the brakes take the form of hinged petals at the extreme tail end of the fuselage which, when opened, form a fish-tail of impressive proportions. Each petal has axial strakes which preserve the flow and doubtless reduce buffeting. It is certain that equivalent drag could not have been incorporated in any other part of the aircraft, and it seems likely that the effect on trim of airbrake operation is also very satisfactory. The sideways-opening petals clearly lie above the jets from the powerplants, and the latter are in any case towed well outwards, as is frequently done to minimize the yawing moment following engine failure.

Little need be said regarding the undercarriage, which looks commendably neat and worthy of the name of Dowty Equipment. The main gear comprises a pair of single oleo struts—which, owing to the mid-mounted wing, are quite long—each bearing a single levered-suspension wheel and pivoted to retract inwards so that the wheel can lie somewhere in the underside of the nacelle close to the jet-pipe. The track is obviously considerable, this always being an advantage for carrier operations. The nose undercarriage likewise has a single wheel carried on a levered-suspension leg and, since the nose of an operational NA.39 would obviously be packed with military equipment, it retracts to the rear into a bay beneath the cockpit floor covered by a pair of doors.

One of the superficially obvious differences between the Scimitar and the Blackburn machine is that the latter makes provision for a crew of two. There are several methods by which two men can be accommodated in a fast aeroplane, and the Royal Navy have experimented with most in recent years. The Sea Venom, for example, has a single canopy over the pilot and navigator, who sit almost side-by-side and thus enjoy optimum intercommunication. There is much to be said for this layout since the two men can work together in an ideal manner; moreover, each occupant has a good view forwards and to one side (the pilot sitting to port), which can be particularly valuable for naval operations. In the Sea Vixen, the navigator sits well down inside the nacelle-like fuselage, the pilot occupying an elevated position on the port side beneath an offset fighter-type canopy. In the NA.39, on the other hand, pilot and navigator each sit on the aircraft centreline, beneath a large and lofty transparent canopy.

Although this arrangement separates the two crew members, it is obviously easier with tandem seating to reduce the drag of the canopy and also to conform to the dictates of area ruling. Moreover, were the forward fuselage made fat enough for side-by-side seating, the resultant airflow would undoubtedly nullify the advantages of high wing sweep at the roots, which can be very valuable at speeds in the neighbourhood of Mach 1. Both pilot and navigator of the NA.39 face forwards in Martin-Baker ejection seats, and the crew compartment generally seems to be surprisingly roomy. It must not be forgotten that, perhaps to an even greater degree than his land counterpart, the naval aviator has to wear advanced types of protective clothing which considerably increase his own bulk; and the navigator must also find room for numerous navigational aids and personal accoutrements. These

The Blackburn NA.39 Strike Aircraft

- Is the world's first specially designed, low-level, high-speed aircraft.
- Has flown on the target date set in 1955 in the original contract.
- Has considerable range and the ability to carry conventional and nuclear weapons.
- Is powered by two de Havilland "Gyron Junior" turbo-jet engines.

Blackburn and General Aircraft Limited, Brough, E. Yorks.

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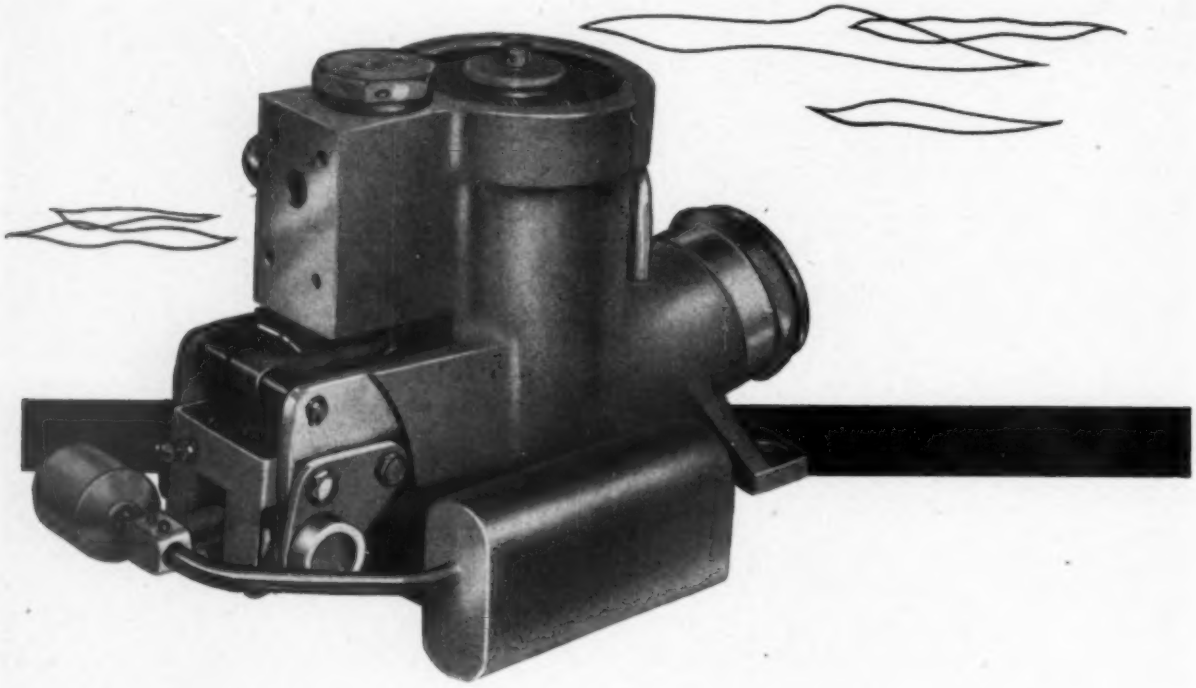

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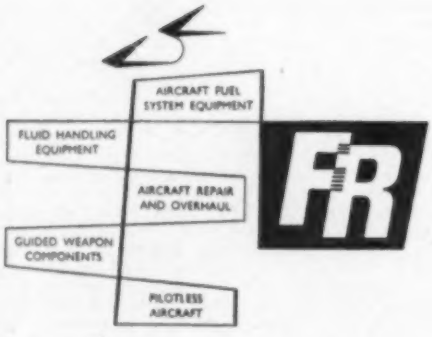
This type of valve is for use in air pressurized engine feed systems and operates in the climb, dive and roll attitudes. It will also operate in the inverted attitude. It will remain open when fuel is present but has a low final shut-off to prevent air entering the engine feed line. This low shut-off ensures that little residual fuel remains in the tank. The use of this type of valve provides a saving in weight over pump feed systems. The valve has good Flow/Pressure Loss characteristics over a very wide temperature range. Variants of this valve can be made which are operated electrically for remote control.



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NA.39 . . .

facts not only demand a large cockpit, but also increase the problems of ejection.

The capacious fuselage, which so obviously conforms to the area rule, is doubtless packed to a high density with operational equipment, tankage and systems, and there is undoubtedly a large internal bomb bay. Some of the unofficial photographs clearly reveal the plan-size of the bomb bay, which one would expect to be large enough to accommodate nuclear stores of high (megaton) yield. These could perhaps be mounted on a rotatable door; or, alternatively, they may be slung conventionally from bomb arches, the bay being closed by hinged or sliding doors. In addition, it would be logical to suppose that provision will be made for at least one stores pylon beneath each wing. As the NA.39 is primarily a bombing aeroplane it is unlikely to carry guns, although it is possible that it could be equipped to carry weapons such as Firestreak should the need arise. The Firestreak system, however, is known to include numerous items carried within the aircraft, and these would either have to displace existing equipment or, as in the case of the R.A.A.F. Avon-Sabre, be mounted as a package faired in beneath the fuselage. It is worth noting that the pilot has an optically flat windscreen.

The area ruling is so pronounced as to be almost grotesque, yet it is a fact that for the transonic regime this sort of shape may well be the optimum. It is a diverting exercise to muse on the manner in which the space inside the body has been utilized to best advantage; tankage would obviously have to be disposed fairly symmetrically about the c.g., the problem being further complicated by the almost continuous variation in fuselage diameter. This may also have created some problems in the longitudinal stressing of the stringers and skin, and in the runs of pipes and powered controls. Most of the latter, however, are doubtless tucked inside the dorsal spine which runs in a curved line from the canopy to the fin (and, in the prototype at least, carries a pair of blade aerials). Incidentally, area ruling, according to the N.A.C.A. Whitcomb law, is probably the best way of displacing streamlines and bringing them together, but there are many aerodynamicists who feel that the R.A.E. Küchemann formula gives better results for local pressure gradients. One can never tell which formula has been used by looking at an aeroplane, but the optimum seems to be a mixture of both; each is certainly wrong if carried to excess.

No dimensions may yet be published for the NA.39, but it must be capable of going down the lift of a carrier. To this end the wings undoubtedly fold and it may have been found essential to hinge the nose also; a hinged nose was essential on the Sea Vixen, the unfolded length of which is 53ft 6½in. One would imagine the overall length of the NA.39 to be greater than this. It would be logical to suppose that the NA.39 is equipped for in-flight refuelling—there are at least three possible methods of mounting the probe—and it would also seem to be a suitable aeroplane for the photo-reconnaissance rôle, although this would probably require a machine designed for very high speed at altitude.

This concludes the "observation and deduction" which can readily be made at this time. To return to the history of the aircraft, it is apparent that Blackburn and General Aircraft, with the assistance of numerous sub-contractors, have produced a flying prototype in three years from the go-ahead. This is particularly remarkable when it is borne in mind that the company previously had practically no experience of transonic aerodynamics, advanced integral structures, electronics, modern flight-instrumentation or even jet propulsion, to say nothing of the fearsome aeroelastic problems posed by such a machine. Naval problems must have been minor ones, for it is not long since the company had teams working on the YA.1, YA.5 and YB.1 strike and anti-submarine designs. It is also worth commenting that Blackburn gained some high-speed experience with the YB.2 crescent-wing research aircraft (the H.P.88).

For four years the company's tunnels have been heavily committed to the NA.39 programme, and a considerable proportion of the effort must have been applied to the problems of boundary-layer control. Mr. Robert Blackburn wrote in 1955: "Some time ago we initiated a good deal of interesting research work on boundary-layer control, which in the simplest terms means operating on the thin layer of slow-moving air at the surface of the wing by sucking or blowing it away. . . . We have obtained much-improved lifting qualities from high-speed, thin, swept-back wings and thus greatly improved the take-off and landing performance." It is known that Blackburn have conducted extensive research with a rig employing one of their own Palouste gas-turbine engines as a source of blowing air. The company also have a share in the Aircraft Research Association's tunnel at Bedford, and in 1956 Mr. Eric Turner said, "the model of our new aeroplane is now being made there and will be one of the first tested." In addition Blackburn now have their own supersonic tunnel, which we described on April 11.

Blackburn are certainly capable of undertaking the complete structural-test programme themselves. The testing facilities at Brough have already handled the complete Beverley wing, the largest major airframe portion ever built in quantity in Britain, and it also seems likely that the NA.39 cockpit will be subjected to the rigours of a tank test. In common with all recent British military machines, the successful operation of the hood-jettison system must have been proven with the large blower tunnel at the A. and A.E.E. and it is fair to assume that all the main accessory systems of the NA.39 have been, and are being, intensively developed at Brough with the aid of ground rigs. Naturally, no details of any of these systems can be deduced from the superficial appearance of the aircraft, but any student of modern accessories could certainly make some close guesses. Low-pressure air starting for the engines seems obvious, and it has already been announced that Blackburn's own Palouste air-starter trolley has been used to start up the NA.39 prototype on its ground runs.

It has been known for several years that the U.S. Mutual Weapons Development Program has assisted the development of numerous items of defence equipment produced in countries friendly to the U.S.A. All such equipment is evaluated; and promising items receive financial and technical support according to the needs of the country concerned, in an effort to produce an effective contribution to Western defence at the earliest possible date. It is no secret that the Blackburn NA.39 design has been evaluated by the U.S. Navy, and that BuAer officers have found it exceedingly good and promising. Exactly what form American assistance in its development will take is uncertain, since "offshore" orders of the traditional type are no longer being placed. It can, however, be said that, under the auspices of M.W.D.P., Blackburn have been given free use of certain types of instrumentation and data-analysis equipment, which will feed the company's own Ferranti Pegasus electronic computer. This equipment will undoubtedly accelerate the flight testing of the development aircraft, the first of which flew on April 30 at the R.A.E., Bedford. The pilot on this first flight was Mr. Derek Whitehead, an ex-Royal Navy, ex-Boscombe pilot who joined the company in January. He will be assisted in the NA.39 flying by "Sailor" Parker, and probably by other pilots as well. It is particularly worth noting that a Meteor NF.12 is being used as a "chase" aircraft; this is one of the first indications that such an obviously worthwhile procedure is being officially adopted in this country.

As was suggested at the beginning of this account, the new Blackburn does not look particularly exceptional. The fact that it is exceptional indicates that its designers have achieved the fine balance between conflicting factors which produces the best compromise and the most successful product. It can certainly be expected to serve the Royal Navy well. Moreover, it is a species of aeroplane—or, as the Americans would say, a delivery system—which could put the R.A.F. into the low-flying business quite soon, and might also find wide acceptance among other air forces.

W. T. G.

Ten NA.39 men in alphabetical order: Line 1, T. Bencroft, production director; R. D. Boot, deputy head of aerodynamics; H. Brumby, project designer; J. Hall, experimental manager. Line 2, B. P. Leight, chief designer; G. R. I. Parker, test pilot; N. E. Rowe, technical director; A. G. Smith, head of aerodynamics; B. Watson, head of flight test (in the back seat on the first flight); D. Whitehead (in the front seat).

Left, "Imperials also sought tenders in 1934 for . . . a large new landplane. This became the Armstrong-Whitworth A.W.27 Ensign." Right, "In 1935 the de Havilland Company . . . started work on their D.H.91 Albatross, aerodynamically a remarkably advanced design."

Origins of the Modern Airliner

PART 3: IN ENGLAND AND GERMANY, 1934-39

By PETER W. BROOKS, B.Sc., A.C.G.I., A.F.R.Ae.S

IN 1934, particularly after the DC-2's striking performance in the MacRobertson Race, the Board of the British "chosen instrument" airline, Imperial Airways, Ltd., came under considerable public pressure to adopt faster aircraft. Until this time British air transport and transport aircraft had held a strong position internationally, but this was now clearly being undermined by the new American aircraft and by the development of the foreign airline industries which they were making possible.

Imperial Airways' main pre-occupation at this time was with the opening-up of the "Empire routes" to the Commonwealth countries, routes which were singularly lacking in good aerodromes and other ground facilities. In planning their new equipment Imperials took the view that the faster British aircraft which they required should be flying-boats, which would not be dependent on the poor Empire-route aerodromes. They accordingly sought tenders in September 1934 for two prototypes of what later became the famous Short Empire flying-boat. A fleet of 28 of these aircraft was eventually ordered, plus further numbers of developed versions. The Empire boat did great work in Imperial Airways service but, in practice, proved economically uncompetitive with the American landplanes and therefore unattractive to airlines generally. It would appear that the direct operating cost per seat-mile of the Empire boat carrying 24 passengers was nearly double that of the 21-passenger DC-3. A comparison of total costs would be even more unfavourable to the flying-boat, because of the higher overheads associated with marine-aircraft operations. The poor competitive showing of the Empire boats and their developments—in spite of their outstanding qualities as aircraft of their type—serves to confirm that, for civil air transport, flying-boats suffer unacceptable economic and operating drawbacks which, when adequate aerodromes are available, cannot be tolerated.

To cover their less pressing landplane commitments, Imperials also sought tenders in 1934 for two prototypes of a large new landplane. This became the Armstrong-Whitworth A.W.27 Ensign, a very large four-engined 40-passenger all-metal cantilever high-wing monoplane, 14 of which were ordered in 1935. Because of serious delays in development, due in part to the manufacturer's pre-occupation with his military commitments, the Ensign did not make its first flight until January 24, 1938. It was a very large aircraft for its time, with a wing area of 2,443 sq ft and a gross weight of 48,500 lb. Unfortunately, it proved to be seriously under-powered (13.8 lb/h.p. with a wing loading of 19.9 lb/sq ft) and, although introduced into service on October 24, 1938, was withdrawn from use after two months to have its 880 h.p. Armstrong-Siddeley Tiger IX engines re-rated to 935 h.p. The Ensigns returned to service in mid-1939 and did good work during the war, particularly after they had been re-engined with still more powerful (1,100 h.p.) American Wright R-1820s.

Well before the Ensign made its long-delayed first flight, other more significant four-engined transports were to be developed in Europe. Before this, however, there was another important event in the United States. On July 28, 1935, Boeing flew the prototype of the famous B-17, "Flying Fortress" bomber and thus once again set a fashion which was to endure. The B-17 was the first four-engined all-metal low-wing monoplane in the "modern" style Its configuration was to be adopted for civil transports by European manufacturers before the Americans did the same.

Also in 1935 the de Havilland Company in this country started work on their D.H.91 Albatross, aerodynamically a remarkably advanced design for a four-engined transport aeroplane of rather more than DC-3 capacity but the same seating accommodation. The prototype flew for the first time on May 20, 1937, and the type was produced thereafter in small numbers; but it lacked the ingredients for full success because it was of wooden construction. Not only did this make it heavy but operators had begun to appreciate the advantages of a durable all-metal airframe.

In Germany, in 1936, two advanced all-metal four-engined designs were projected for Lufthansa. Construction of prototypes of the Junkers Ju 90 and Focke-Wulf Fw 200 Condor started soon after and both types flew for the first time in mid-1937. They were then put into production. Small numbers went into airline and military service in 1938 and a development of the Condor was extensively used by the Luftwaffe during the War on long-range anti-shipping work. The Condor was used in limited numbers by airlines in Germany, and abroad—notably in South America. A few remained in service until after the war. However, neither the Ju 90 nor the Fw 200 achieved the widespread success in its designed rôle which it might have had but for the War.

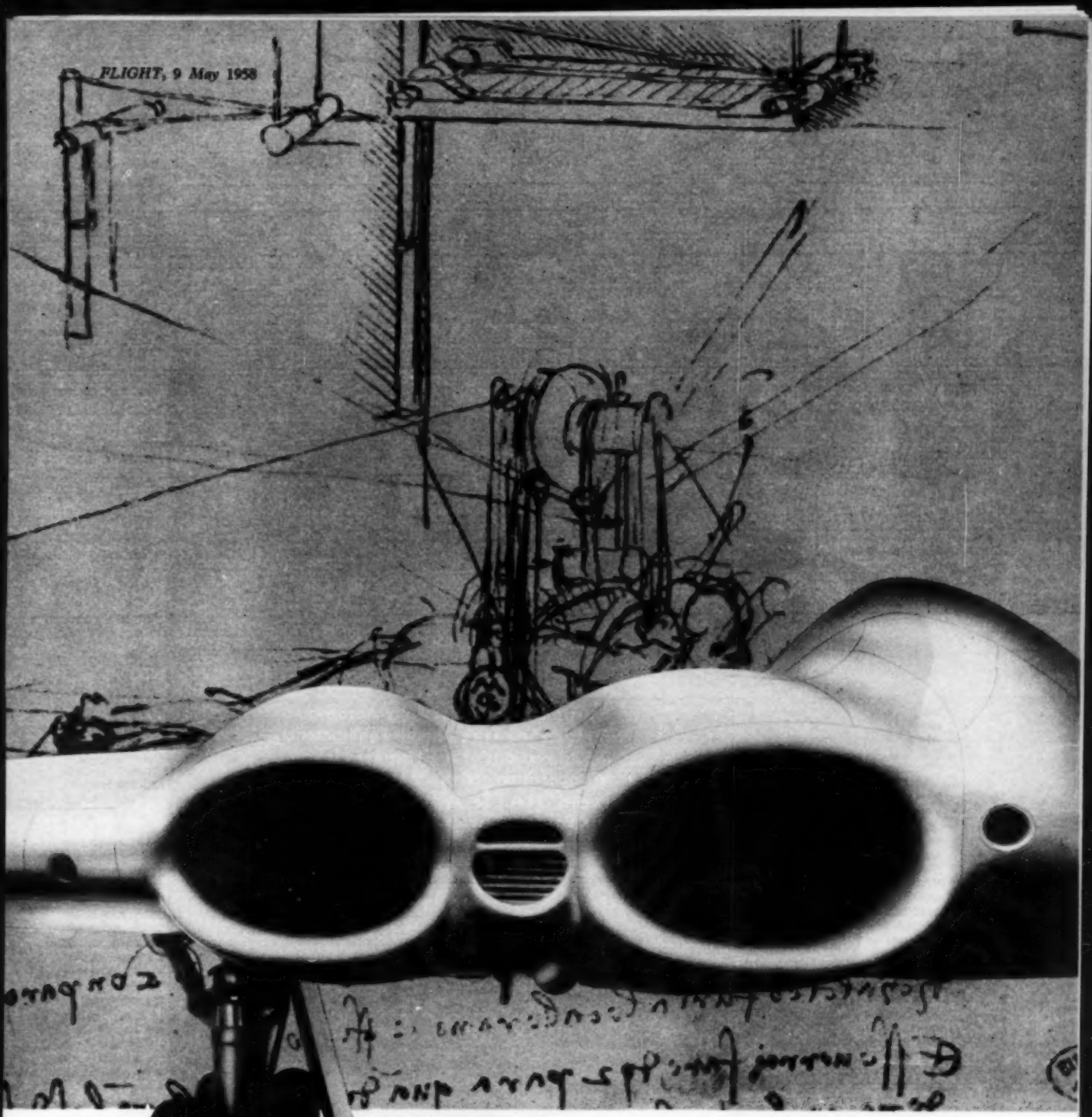
Also in 1938, the British Air Ministry issued the 14/38 and 15/38 specifications for two new large transport aircraft, the former roughly in the category of the Ju 90 (whose wing area was 1,980 sq ft) and the latter in that of the Fw 200 (wing area: 1,291 sq ft). Soon after, orders were placed to these requirements for three prototypes of the Short S.32 and for 14 production Fairey F.C.1s—the first "modern-type" British transports. Both contracts were later cancelled because of the outbreak of war, but it is interesting that these two four-engine, pressurized, all-metal designs—which had wing areas of 2,040 sq ft and 1,300 sq ft respectively—bracketed the size range which was later to be so successfully exploited by the Americans with their contemporary DC-4 and Constellation.

The S.32 was a mid-wing monoplane with four Bristol Hercules radials. This configuration involved a massive—and no doubt heavy—centre-section frame to carry the spar loads round the cabin and would probably have proved a drawback because of the difficulties of making economical use of the fuselage volume. Furthermore, the design had a tailwheel undercarriage, partly because of the anticipated difficulty of retracting a nosewheel into the pressurized fuselage. The F.C.1, on the other hand, which had four Bristol Taurus radials, was of conventional low-wing layout with a tricycle undercarriage and a circular-section fuselage with freight hold below the floor. The internal fuselage diameter was 122in, which compares with the 118in of the DC-4. The wing was a two-spar structure and it was to have been of the new N.A.C.A. 23-series section which had been developed at Langley Field in 1934. It was 18 per cent thick at the root and 10 per cent at the tip and had area-increasing Youngman flaps of advanced design. The F.C.1 had a triple tail, rather in the style which was later to become familiar on the Constellation, whereas the S.32 had end-plate fins and rudders on the tailplane.

The F.C.1 would have required some "stretching" to make it fully competitive in developed form with the DC-4 and Constellation series, but the design held great promise. It had the added distinction of being the first transport aeroplane in the world to be ordered into production which incorporated all the major features which were later to characterize the DC-4 generation. If the F.C.1 and S.32—together with the Ju 90 and Fw 200—had had their chance, American long-range transport aircraft might not have had such a clear field in the years after the war.

(To be continued)

"In Germany, in 1936, two advanced four-engined designs were projected for Lufthansa. Construction of the Junkers Ju 90 [below] and Focke-Wulf Fw 200 Condor started soon after."



Background illustration from Leonardo da Vinci's notebooks (c.1508) "Design for a flying machine".

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"Flight" photograph

HUNTER F.6

First Full Description of an Outstanding Fighter and Ground-Attack Aircraft

IN terms of financial investment and return the Hawker Hunter is probably the most valuable aircraft to come from the British aircraft industry since World War 2—and the only one to reach the coveted "billion-dollar" class. Its progress also makes one of our most heartening success stories during that time. Despite the fact that the huge flood of single-seat Hunters for the R.A.F. has now dwindled to a trickle, the Hawker factories at Kingston-on-Thames and Dunsfold are still working at full pressure to meet export orders which will keep them busy for at least two years. Moreover, the Hunter has won these export orders in the face of fierce competition, and it will go down in aircraft history as one of the classic fighters.

Its severest test to date, and one from which it emerged with flying colours, was the comprehensive evaluation carried out by the Swiss Air Force during the summer of last year. French, Canadian, American and even the indigenous Swiss design specially prepared for Alpine conditions were bettered by the remarkable all-round qualities of the Hunter F.6, both as a fighter and as a ground-attack machine; and although it still ranks as a day fighter in many air forces, it has also undoubtedly proved itself to be the finest ground-attack aircraft at present available anywhere in the world. As a gun-platform, as a carrier of stores and as a pilot's aircraft it outperformed and outgunned any other type the Swiss were considering at the time. Its cost is also remarkably low—thanks to the fact that it is right down at the bottom of its "learning curve."

Hunters are now in service with the British, Swedish, Danish, Dutch, Belgian, Peruvian, Indian and Iraqi air forces; and they are on order for the Swiss. Dutch and Belgian machines have been made under licence by Fokker, Aviolanda, SABCA and Avions Fairey.

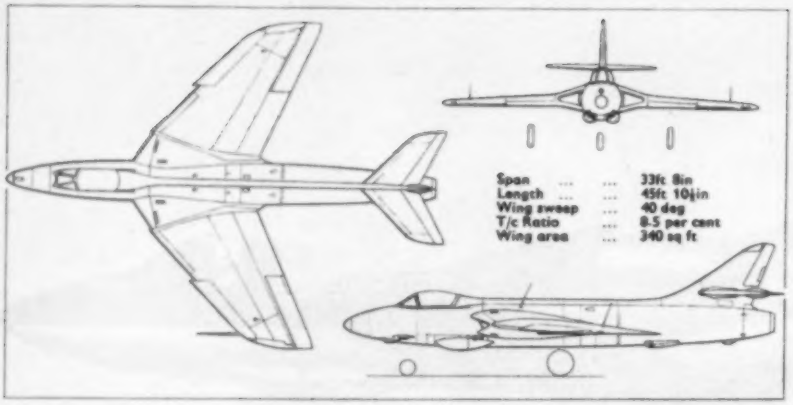
An undisclosed, but substantial, number of Hunters was ordered "off the drawing board" for Fighter Command in 1951. This was supported early in 1954 by an American offshore order for a large number of Hunters, many of which were to be issued to the R.A.F. A further 112 offshore Hunters were built under licence by the Dutch/Belgian consortium mentioned above. On their own account the Dutch Government then ordered 156 Hunters direct from Fokker and the Belgian Government ordered 192 from their companies. Hawkers supplied 30 to Denmark; and Sweden bought 120. In 1954 a further offshore order worth £367 million was placed in England by USAFE for both Hunters and Javelins, the exact number of Hunters involved not being stated. The Indian and Swiss orders each include over 100 machines; and Hawker Aircraft are confident that negotiations now in progress will result in several more new orders. Altogether, well over 1,000 Hunters have been built, excluding trainers.

Hunters were produced in Britain by Hawker's factory at Squires Gate, near Blackpool, as well as at Kingston; and Armstrong Whitworth also built all the Hunter F.2s, F.5s and some F.6s at Baginton. Now only the Kingston factory remains in Hunter production, with final assembly, flight testing and conversion of some foreign pilots being handled at Dunsfold. Here a remarkable team of pilots is at work, headed by A. W. ("Bill") Bedford, testing new Hunters and training overseas personnel.

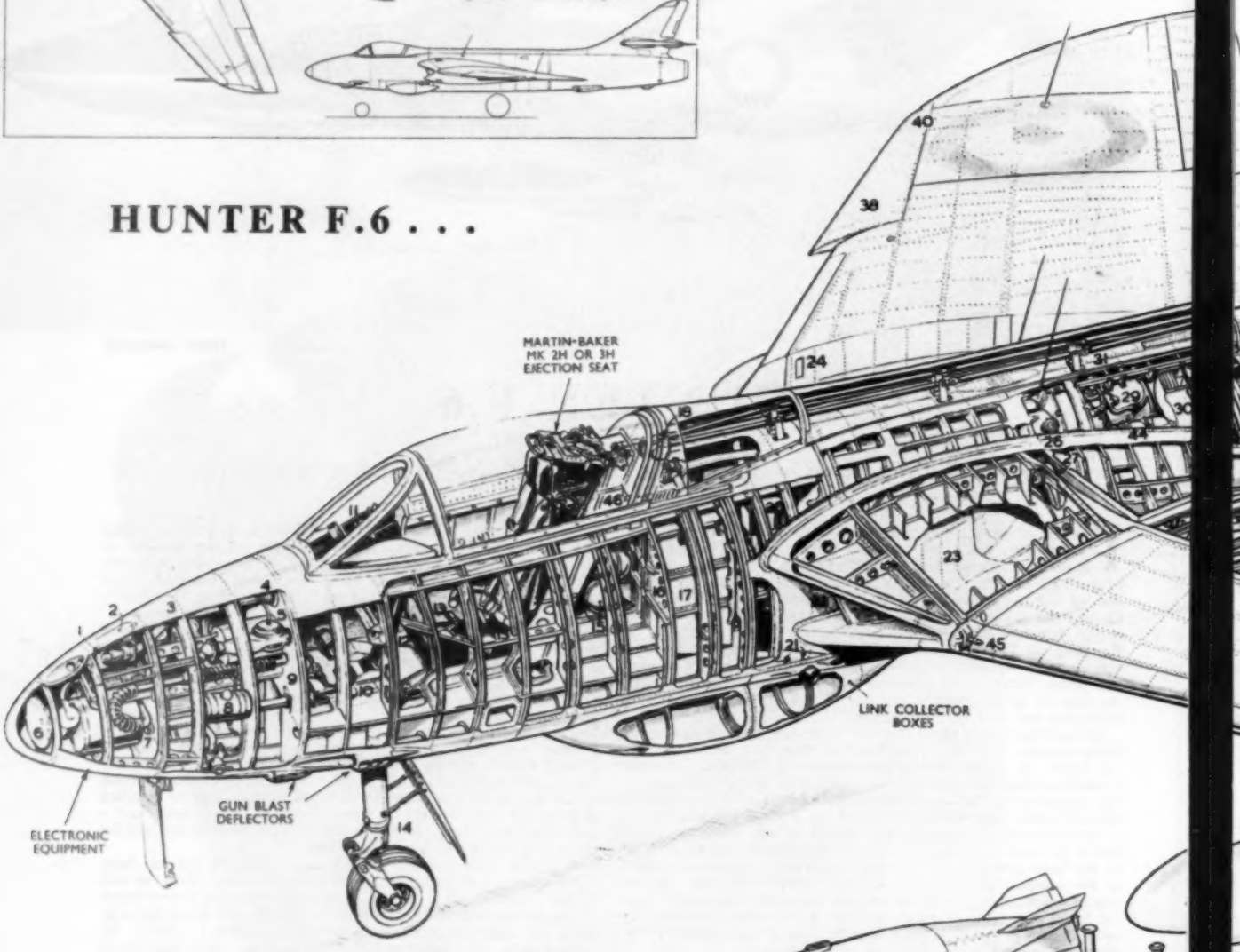
Since Neville Duke, then chief test pilot, made the first flight of the prototype P.1067 on July 20, 1951, there have been no fewer than 127 variations on the basic theme; some of them were minor, others were purely for research; but most aimed at increasing the operational capabilities of the squadron aircraft. The principal variants are listed in the table on page 640. It has been shown that the Hunter can carry guided air-to-air weapons, a very heavy external load of fuel for ferrying flights, a wide variety of air-to-ground rockets, bombs of various sizes and honeycomb launchers for unguided air-to-air rockets—all in addition to the hard-hitting 4 × 30 mm Aden gun pack. In addition, cameras can be installed in a special nose section for fighter/reconnaissance work, and a two-seat (side-by-side) cockpit has been successfully developed for either training or special tactical rôles.

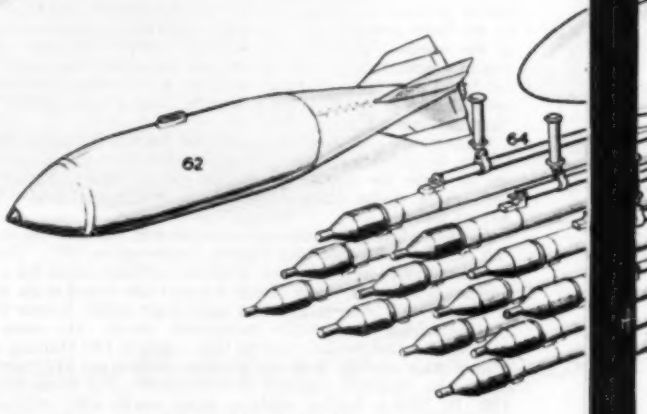
A trainer version based on the lower-powered F.4 has been ordered for the R.A.F. (Mk 7) and Fleet Air Arm (Mk 8) as well as the Danish air force (Mk 53). The more powerful trainer based on the Mk 6, ordered by India as the Mk 66, was flown last year by C. M. Lambert of *Flight*'s staff (issue of May 17, 1957). He remarked that the Hunter would climb in under 7 min from rest to over 47,000ft and that the throttle could be slammed open and shut at stalling speed at these heights without causing flame-out or surging. Manœuvrability at transonic speeds, with the follow-up tailplane, was precise and effective; and a speed of over 600 kt was reached in level flight at a height of about 100ft. Touch-down speed was about 110 kt. The Swiss trials amply demonstrated the ability of the Hunter to operate from small airfields tucked away high up in narrow valleys, and to deliver 30 mm shells, rockets and bombs accurately against mountain targets. The standard rocket armament consists of the British Mk 12 rail carrying 3in rocket-motors fitted with either 60 lb or 25 lb heads of various kinds, although the Hunter has also been fitted with Oerlikon, Hispano and Bofors rails and rockets. The American 5in HVAR has been carried, as have various bombs of different weights and nationalities. For R.A.F. training purposes the Saro carrier for two 25 lb practice bombs is also used. (A stores-diagram appears on page 638.)

External tankage includes jettisonable tanks of either 100 or 230 Imp gal capacity, carried in any symmetrical combination. The large tanks have been tested, but are not at the moment standard equipment for the R.A.F. Up to four 100-gal napalm tanks can be carried; and these have been demonstrated in Switzerland and Iraq. [*Continued overleaf*



HUNTER F.6 . . .

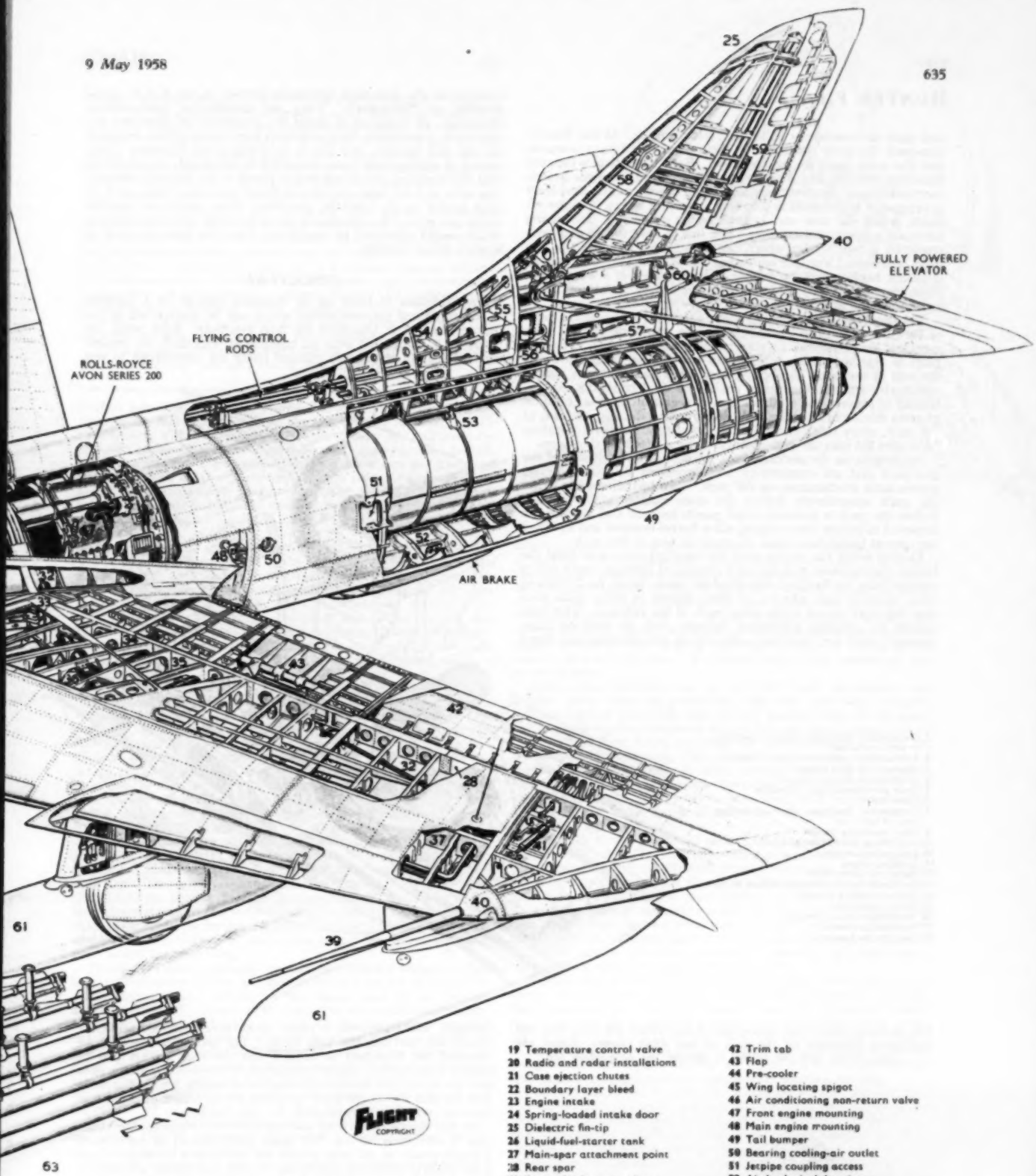




The permanent armament feature is the pack of four 30 mm Aden guns, firing high-velocity ammunition. For rearming, the pack is lowered from the aircraft, with the aid of three Type C bomb-hoists, on to a cradle running on casters which is in turn picked up by a rubber-tyred trolley fitted with its own hydraulic fork-lift. Several of these can be towed to the armoury by Land-Rover for rearming; and the guns are normally harmonized in the pack away from the airframe. Before the pack is taken out, the barrels are detached from the breech mechanisms and the whole system is so arranged that any barrel will fit any gun and any pack will fit any aircraft. Complete interchangeability is thus provided, and results have shown that a high degree of accuracy is nevertheless maintained. The gun-sight and battle camera are harmonized separately with the airframe.

Effective performance of the gun-pack has been conclusively demonstrated in the most rigorous tests. Unrestricted firing is allowed in any attitude, at any speed and at any height, considerable positive and negative g being tolerated. A truly marathon firing trial was carried out during development. Some 20,000 rounds were fired through one gun pack under the most difficult flight conditions (500ft and 600 kt). Each time the trigger was held to discharge the full ammunition load in one burst and the aircraft was brought straight back to Dunsfold for rearming. After the 20,000 rounds the whole installation was inspected, some very slight modifications were incorporated and a second cycle of 20,000 rounds were then fired off without any trouble. This performance, Hawkers claim, is unequalled by that of any other gun-firing aircraft in the world—30 mm or otherwise.

The Aden gun does not require to be mounted right-way up;



1 Battle camera
2 Camera magazine access
3 Oxygen bottles
4 Ram air valve
5 Cabin pressurization valve
6 Radar ranging
7 Ground pressurization connection
8 Anti-icing fluid tank
9 Forward pressurization bulkhead
10 Rudder pedals
11 Gun-sight
12 Control column
13 Engine controls
14 Forward-retracting nosewheel
15 Compressed air bottles (4)
16 Rear pressurization bulkhead
17 Gun pack
18 Cabin air auxiliary discharge valve
19 Temperature control valve
20 Radio and radar installations
21 Case ejection chutes
22 Boundary layer bleed
23 Engine intake
24 Spring-loaded intake door
25 Dielectric fin-tip
26 Liquid-fuel-starter tank
27 Main-spar attachment point
28 Rear spar
29 Pre-cooler by-pass valve
30 Cooling air outlet
31 Cold-air unit
32 Aileron control run
33 Rear spar attachment point
34 Synchronizing jack
35 Flap actuating jack
36 Undercarriage jack
37 Main spar
38 Saw-tooth leading edge
39 Pressure head
40 Lights
41 Aileron Hydrobooster
42 Trim tab
43 Flap
44 Pre-cooler
45 Wing locating spigot
46 Air conditioning non-return valve
47 Front engine mounting
48 Main engine mounting
49 Tail bumper
50 Bearing cooling-air outlet
51 Jetpipe coupling access
52 Air-brake jack housing
53 Jetpipe rail
54 Rudder-lever mounting
55 Hydraulic-accumulator mounting
56 Tailplane actuator
57 Elevator booster
58 Rudder control-run
59 Trim-tab actuator
60 Tailplane pivot
61 100 gal plastic drop tanks
62 1,000 lb bomb
63 12 × 3 in RP
64 Mk 12 RP rails

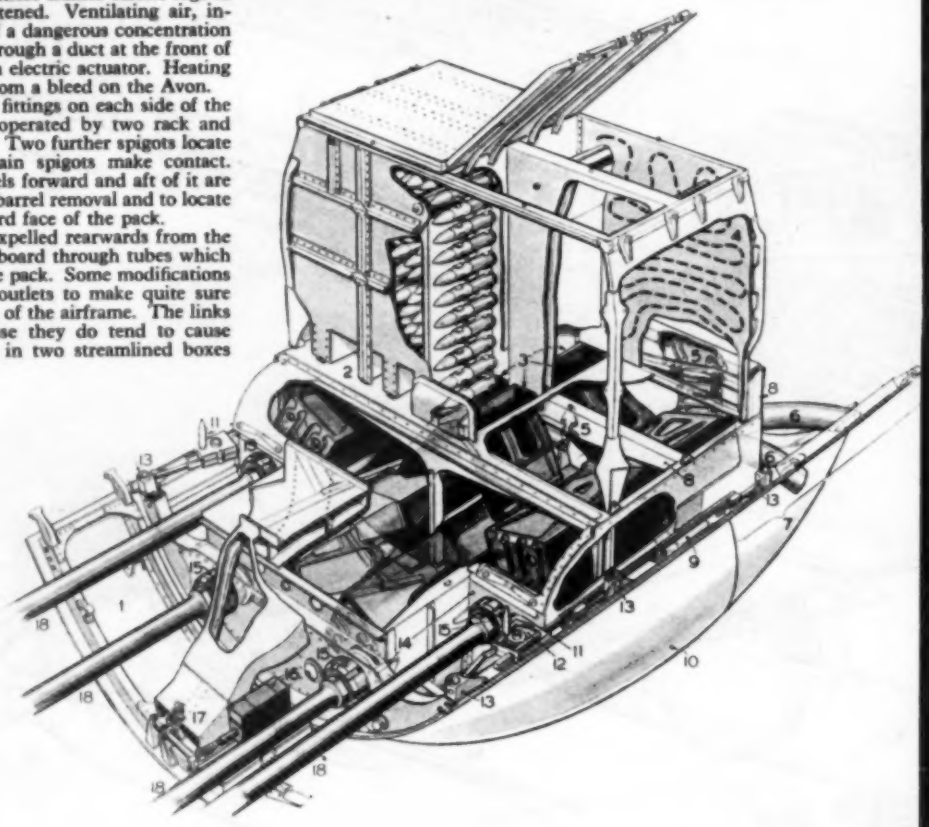
HUNTER F.6 . . .

and such an attachment is, in fact, seldom made. In the Hunter gun-pack the inner Adens lie on their sides, lower faces inwards, and the outer guns are upside down. Each barrel has a forward steadying bracket, but may be quickly detached from the breech mechanism and removed forwards. The breech mechanism itself is supported at the front in a spherical bearing taking fore-and-aft loads, while the rear end is held by an adjustable link giving torsional support and location. The link is held to the gun-pack frame by a captive bolt which can be adjusted to move the gun body sideways. Vertical adjustment is achieved by rotating an eccentric bush round the captive bolt by means of a worm gear. Alignment of guns is achieved with the aid of a sighting prism inserted at the muzzle and trained on a special marker board.

The inner guns are mounted slightly forward of the outers, pairs of forward mountings being held in two transverse frames, with a central keel structure helping to bear reaction loads. The two pairs of rear mountings are held in two further frames towards the rear of the pack. A decking over these frames carries lugs to which the ammunition tanks are fastened. Ventilating air, intended to prevent the accumulation of a dangerous concentration of gases during firing, is brought in through a duct at the front of the pack, entry being controlled by an electric actuator. Heating air is also led into the gun-chamber from a bleed on the Avon.

Six spigots on the airframe pick up fittings on each side of the gun-pack and are retained by bolts operated by two rack and pinion latch mechanisms on the pack. Two further spigots locate the pack immediately before the main spigots make contact. Before the pack is lowered, small panels forward and aft of it are removed to expose connections, allow barrel removal and to locate the central bomb-hoist near the forward face of the pack.

During firing the empty cases are expelled rearwards from the breech mechanisms and dropped overboard through tubes which emerge from the fuselage just aft of the pack. Some modifications have recently been effected to these outlets to make quite sure that the cases do not strike other parts of the airframe. The links cannot be similarly jettisoned, because they do tend to cause damage; they are therefore collected in two streamlined boxes attached to the gun-pack (generally known in the R.A.F., incidentally, as "Sabrinas"). They are secured by quick-release fastenings, all designed to avoid the possibility of improper replacement. In addition, blast deflecters have recently been designed for the gun muzzles and are to be fitted to all Hunters. They consist of welded-steel boxes mounted in the mouth of each firing tube and standing one or two inches proud of the fuselage contour. Cascades of four vanes in each deflecter box turn blast away at right angles to the fuselage, providing about 160 lb of upward thrust per gun. This eliminates the nose-down pitching moment which would otherwise be significant when the guns are used at heights above 35,000ft.



1 Detachable fuselage panel carrying ventilation scoop
2 Ammunition container support floor
3 Ammunition feed chutes
4 Ammunition flaking diagram
5 Rear gun mountings, adjustable
6 Case chutes
7 Detachable fuselage panel, including rear of link case
8 Rear mounting frames
9 Link chute, port outer gun
10 Link collector box
11 Guiding spigot
12 Rack-and-pinion latch
13 Gun-pack retainer fittings locked by 12
14 Front mounting frames
15 Front mountings
16 Ventilation intake actuator
17 Ventilation intake
18 Detachable barrels

The drawing above and photograph below detail the structure and unshipping technique for the pack of four Aden cannon. Below, the rubber-tyred, fork-lift trolley is beyond the nose-wheel leg.

STRUCTURE

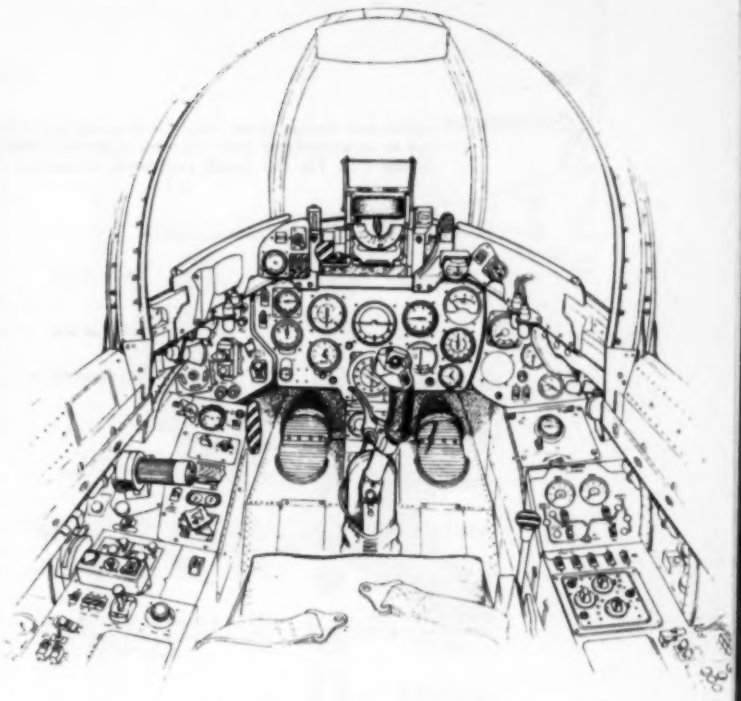
The airframe is built up in standard jigging as a number of self-contained sub-assemblies which can be transported to the makers' airfield at Dunsfold for final assembly. Each wing, for instance, is completed with all equipment, including the undercarriage leg, all tested and painted ready for attachment to any fuselage. The latter, too, is made up in three equipped units, the central one carrying the stub wings. The cockpit section can be detached for transport or repair; and the rear section can be readily detached for engine installation or removal. Extreme nose and tail cones are virtually fairings attached by toggle fasteners. The fin and the single-piece tailplane are mounted on a fin-root structure which is integral with the rear fuselage.

As the cut-away drawing on pages 634-635 suggests, the structure is extremely strong, but quite conventional in conception. Though many of the skin panels are rolled to a curvature, there is no integral stiffening; and stringers, ribs and frames are built up from formed plate and light extrusions. There are few large forgings, and very little steel is used. Such relative simplicity is a very real advantage in ensuring ease of repair, since there is still no effective way of repairing the massive, integrally stiffened structures now being increasingly used in military aircraft.

Fuselage frames are numbered from 1 to 63, the forward section extending between 1 and 18A and the centre between 19 and 40A. Material is generally D.T.D. 610 (L.72). Although centre and rear sections are built up from closely spaced frames and many stringers, the forward section is based on four heavy longerons, the lower pair being of built-up top-hat section and those above

having a pyramid section reinforced by extruded angles. In addition, a keel structure between frames 8 to 11 takes nosewheel drag loads, the retraction jack and surrounding items. The pressure cabin is contained by bulkheads at frames 6 and 14 and by the cockpit floor, a trunk passing diagonally up through the rear portion to house the control runs. Support for the cockpit coaming and windscreen is provided by the top longerons, they in their turn being assisted in bearing canopy-locking loads by frames 10 and 13, which are doubled for this purpose. The canopy is a normal blown plastic unit running on rails and moved via a chain gear by an electric motor at the rear and to port. It is jettisoned by a cartridge-operated piston jack at each side, initiated either by the pulling of the ejection-seat blind or by a separate manual control. The windscreen is a double-layered unit made up from laminated bullet-proof glass mounted in a rubber channel and clamped down by fairing strips screwed to the supporting pillars. An air-space between thick outer and thin inner glass layers is kept dry by silica-gel capsules. Quarter lights are of ¼in-thick Perspex.

The fuselage forward of frame 6 houses the retracted nosewheel, the radar-ranging gear and one of the pressurization valves. Aft



Cockpit layout of a standard Hunter F.6. Items frequently used are close to the left hand. Thus, on the left, reading forwards, are air conditioning; V.H.F. radio; engine relight; aileron and tail stand-by; throttle; undercarriage and flap main and stand-by; and control-power engagement. The main blind-flying panel has gun-sight and weapon controls above and starting switches below. To the right are D.M.E.; oxygen regulator; diagrammatic fuel system; D.M.E. control; g-suit outlet; and various test connections.

of frame 14 lie the ammunition cans, taking up the full fuselage width, and these form a part of the gun-pack containing the four Aden in the underside of the fuselage. The next space aft houses radio and electrical-control equipment mounted on racks between frames 16 and 18A. Here the skins are mainly of 16 s.w.g., with 14 s.w.g. where gun-blast has to be resisted and 10 s.w.g. around the base of the windscreen, where deflection-armour qualities are required. Control runs and certain air-conditioning components are housed in the dorsal spine, which is an unstressed and detachable fairing in this area.

The centre fuselage carries the main body of the engine with its mountings and the stub wings and, as already indicated, it emerges from the factory as complete unit ready to receive front and rear fuselages, engine and wings. The general structure comprises closely spaced frames and stringers formed of plate and extrusions, skinned with 14 and 16 s.w.g. sheet. Frame 19 itself carries the intake frame terminating in spigots bearing the torsional loads from the forward section of the wing. The lips of the intakes are built as part of the centre fuselage and contain the sprung doors giving extra intake area for slow-speed operation as well as the boundary-layer bleed ducts.

Main wing loads are taken through the double-diaphragm frame 25 which has extruded booms and plate webs surrounding two machined, H-section spar members which actually pick up the spar lugs. The lower of these members is in D.T.D. 364. Wing drag loads are passed into the fuselage at ring frame 32 through steel channel running forward to frame 29 from each pin. Fuselage shear loads are borne by two machined top-hat light-alloy longerons and by the skin, which is continuous round the cylindrical fuselage, inside the stub wing.

Frame 34 is again reinforced to carry the forward engine mounting. Intermediate frames are mostly divided on the underside to accommodate access panels for the engine and its accessories, although frames 37, 38 and 39 are complete and reinforced in order to transmit some of the shears from the fuselage-break into the continuous upper sections. A thrust member between frames 38 and 40A transmits these loads from the main engine mounting at frame 40A. Fuselage joints both fore and aft of the centre section are of the spigot-and-nut type, though the forward one is not intended for dismantling except for major maintenance and transport.

No structural loads are carried by the main intake trunk; and the intake ring of the engine is pressed against a rubber seal at the end of the duct, level with frame 31.

As might be expected, the rear fuselage is a simpler version of the centre section, and is made up of closely-spaced frames and stringers, the main joint being located at frame 40B. Towards this point the light extruded stringers are reinforced by combined bulb and L-section stringers which terminate at the joint fittings. A few inches aft of this lies frame 41, which forms the forward bulkhead of the after tank bay, reaching from frame 41 to 45. Stainless-steel skins protect the alloy-lined bays from jet-pipe heat. Air-brake jack loads are taken in an 18 s.w.g., built-up case between frames 47 and 50, while the hinges are held in 16 s.w.g. channels between frames 45 and 46. The surface is skinned in 10 s.w.g. sheet.

Aft of frame 46 the dorsal spine begins to take the fin contour on ribs attached to the fuselage decking. Both fin and tailplane are mounted on two posts built integrally with the reinforced frames 52 and 55. The tailplane jack, mounted ahead of frame 52, operates the tailplane beak which projects through frame 52, the main pivot (and the rear spar of the fin) being held in a steel forging at frame 55. A box structure between the two carries the elevator jack. Between frames 55 and 56 lies the tailpipe support bracket, aft of which the tail cone is attached by four locating spigots and four toggle fasteners. The sloping frame in this area is a relic of the earlier shorter tail-cone. A stainless-steel ring surrounds the actual nozzle.

Single-piece tailplane and fin are both built up around two formed plate spars supported by ribs and spanwise stringers. Rudder control push-rods pass up the leading edge and through the fin between closely-spaced ribs, while the three central ribs of the tailplane form a box carrying the hinge brackets aft and the operating beak forward. The elevator surfaces are operated by pivot shafts terminating at their inboard ends in a common universal joint holding a single operating lever connected to the jack. Both rudder and elevators have lead mass-balances within shrouds ahead of the hinge line and are conventionally built up from plate spars and ribs.

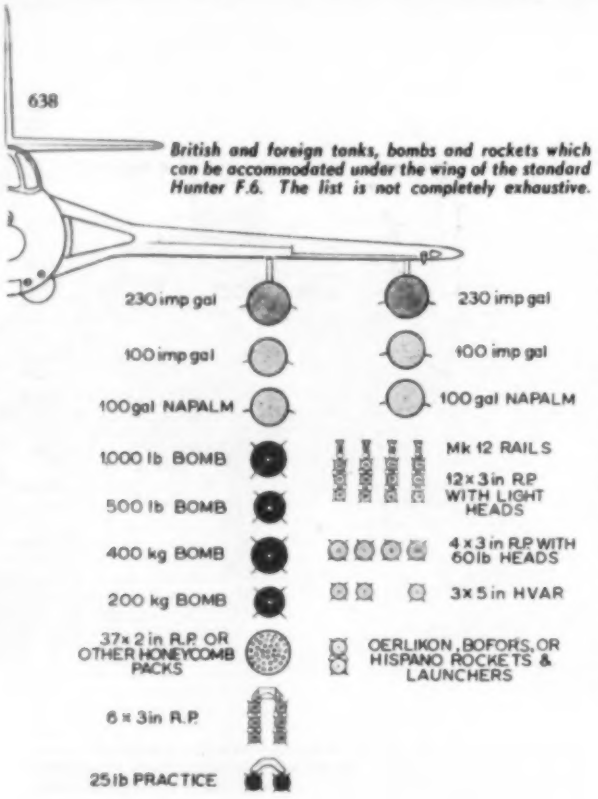
The Rolls-Royce Avon 200 series engine (described in detail in *Flight* for October 11, 1957) is installed in the fuselage as a power-plant complete with its firewall, Plessey iso-propyl nitrate starter, oil system and fuel-cooled oil cooler. The accessory shaft on the port side is coupled to a shaft system driving a Rotol gearbox mounted as part of the airframe low down to port in the engine-bay. From this the two generators and the hydraulic pump are directly driven. They remain in the airframe after engine removal. The i.p.n. starter system is electrically controlled and fed from a tank holding sufficient liquid for three starts.

The firewall, which is mounted on the engine, corresponds with frame 38 and divides the engine bay into two fire zones. Graviner flame-switches are distributed round these two areas and round the tail-pipe and arranged to operate a warning light in the cockpit. The light is set in a button which can be immediately pushed to release foam from two separate bottles into one spray-ring forward of the firewall and another aft of it. An inertia switch will also initiate the extinguisher system after a crash landing.

For removal of the engine, the tail fairing is first detached and the tail-pip run out on its gantry rail. All leads and fuel lines are separated, hydraulic lines being automatically shut off by Lockheed self-sealing couplings. The rear fuselage spigots are then undone and the whole rear fuselage wheeled away on a special trolley, leaving the rear of the engine exposed. Another trolley is then connected to the centre fuselage so that the engine mountings may be unfastened and the engine rolled along the rails built into the fuselage and straight onto equivalent rails on the trolley. The i.p.n. starter comes away complete with its piping. The reverse of this sequence serves to replace an engine and the aircraft can be ready for ground running in a matter of a few hours.

In addition to the power taken from the engine at the accessory drive, air is bled from the compressor delivery to supply cockpit and fuel-system air, while a further bleed feeds heating air to the gun-pack. N.A.C.A.-type flush air intakes round the engine bay ensure ventilation, while fuel and other drains have various outlets around the after fuselage.

[Continued overleaf


230 imp gal
100 imp gal
100 gal NAPALM
1000 lb BOMB
500 lb BOMB
400 kg BOMB
200 kg BOMB
37 x 2 in R.P. OR OTHER HONEYCOMB PACKS
6 x 3in R.P.
25 lb PRACTICE
230 imp gal
100 imp gal
100 gal NAPALM
Mk 12 RAILS
12 x 3 in R.P. WITH LIGHT HEADS
4 x 3 in R.P. WITH 60lb HEADS
3 x 5 in HVAR
OERLIKON, BOFORS, OR HISPANO ROCKETS & LAUNCHERS

British and foreign tanks, bombs and rockets which can be accommodated under the wing of the standard Hunter F.6. The list is not completely exhaustive.

HUNTER F.6 . . .

Wing structure follows fairly closely the principles employed in the fuselage, plate and extrusions being combined into both transverse and longitudinal stiffening, covered with large skin panels of relatively heavy gauge rolled to a curvature. Rib stations are lettered and numbered, those ahead of the main spar reading (from the root rib A) 1, 2, 3, G, H, J, K, L, M, N, P, Q1, Q2, and R. The main frame of the wing is formed by the front and rear spars, the undercarriage girder (lying diagonally between the two) and the strong ribs A, G, M, and R, which have plate webs and extruded booms. Rib A is the root rib lying against the stub wing; rib G is cranked aft of the main spar to lie normal to the undercarriage girder; rib M carries a butt strap for chordwise wing-skin joints; and rib R closes the main spar, carries a butt strap, and mounts the aileron Hydrobooster and the spar extensions holding the end rib and detachable wing-tip and, to port, the pitot boom. Intermediate ribs are simpler flanged plates with lightening holes.

Both main and rear spars are simple plate channel-sections, though extruded booms replace flanges in the main spar inboard of rib J. This structure is progressively strengthened, having steel booms inboard of rib E and terminates in the splayed fork and lugs with which it picks up the steel fittings on fuselage frame 25. The securing pins are tapered steel, with split bushes, fastened by a nut and cup washer. Drag loads from the wing are taken by the top skin and resisted at the rear wing pins on fuselage frame 32. The rear spar joins the undercarriage girder near the pin joint.

An undercarriage pivot bracket is built into the space between main spar, undercarriage girder and rib G, the leg and part of the wheel retracting into the space between spar and girder. The decking over the bay is supported by top-hat-section stiffeners interspersed with steel and alloy extrusions. A goodly quantity of hydraulic, electric and fuel system leads are concentrated in the bay within easy reach from the ground. Main wing loads are transferred from the rib-and-spar complex outboard of rib G, to the structure ahead of the spar, heavy steel gusset plates serving to take bending loads across the crank in rib G itself.

Aft of the rear spar, the decking over the flaps is held by tapered top-hat ribs mounted on forged brackets and covered by plate reinforcing near their roots. This light decking is skinned both above and below. Brackets for flap hinges and operating and synchronizing jacks are of plate and forgings. Similarly, the aileron shroud is supported on forgings, with hinge and actuating brackets of composite construction. The ailerons themselves are made up of plate ribs and stringers based on a channel-section spar, with lead mass-balances in the nose sections. The port aileron also carries the trim tab on a piano hinge, with its electric actuator in the aileron itself.

The flap structure is based on a tubular spar to which are through-bolted forgings forming either roots for the tapering top-hat section ribs, or hinge and operating brackets, or both. Trailing edges are stabilized by doubler strips and a perforated sheet is riveted over the ribs. The flap surface itself is a single skin. Some slot effect is provided for in the geometry of the hinge brackets.

To form the main wing-skin, very large panels of 10 s.w.g. alloy are flush-riveted to ribs and stringers, three of them covering each wing surface out to rib R. They are rolled to contour and butt-jointed along the leading edge, the inner surface of the joint being formed by a butt strap. Outboard of rib R, 14 gauge is used; and the decking over the flaps is skinned with 18 gauge sheet.

The pylons, both inboard and outboard, are based on a cast sole-plate contacting tank or bomb and supported from extruded flanges, bolted to the wing skin and internal structure, by extruded channel-section stringers. The pylon is covered with a sheet skin. Suspension of bomb or tank is by a Vickers bomb-slip which can be lowered to pick up the store by a built-in screw-jack operated from above the wing. A jettison mechanism and the fuel by-pass valve are located within the pylon. Rocket rails of the standard Service Mk 12 type are mounted on posts quickly secured at reinforced cutouts in both upper and lower wing skins. Two posts hold each rail and three of the four pairs of posts in each wing are located between ribs M and R. Bolts retaining the pylons are screwed into blind nuts held in brackets specially positioned next to the relevant ribs. In the case of the outer pylon, rib Q is duplicated ahead of the spar as Q1 and Q2 in order to accommodate these brackets.

The saw-tooth leading-edge extension which is now becoming increasingly familiar on several marks of Hunter is a simple retrospective modification. It is in fact a single sheet wrapped round short plate ribs and riveted directly onto the wing skin between ribs R and J. The trailing edge of this skin is slightly tapered, but kept thick enough to accommodate rivet heads.

SYSTEMS

Powered Controls. The powered control system of the Hunter has gone through a number of variations and modifications, each providing some distinct improvement in handling, and resulting finally in a control system which leaves little to be desired. The main changes have brought the horizontal tail control from a boosted elevator and electrically trimmed tailplane, through fully powered elevator, to fully powered elevator combined with a follow-up tailplane. As reported by C. M. Lambert in his flight evaluation of the Hunter two-seater (*Flight*, May 17, 1957), it now remains fully effective and light even in the most difficult conditions at transonic speeds.

The rudder is purely "manual," with an electric trim-tab to counteract any unusual asymmetric conditions. This tab may also be connected to an autostabilizer made by Newmark. The surface is hardly used at high speeds. Full power and plain spring feel are applied to the ailerons, with manual reversion and automatic doubling of mechanical advantage as a stand-by. For this eventuality, also, an electric trim tab is provided on the port aileron to relieve out-of-trim forces. With power engaged, lateral trim can be adjusted by offsetting the centre position of the spring-feel unit which is located on the control column itself. Aileron feel is substantially linear, with a maximum force of 8 lb at full deflection; and the springs are preloaded to provide positive centring and a slight break-out force. The trim tabs are powered by Rotax actuators.

The hydraulic control-surface jacks are Fairey Hydroboosters (one each for ailerons and elevator); and each is anchored to the airframe by a pawl engaging in a slot in the piston rod. The pilot's input rods actuate the valve and the body of the jack moves the surface. The pawl is held in engagement by the main hydraulic supply pressure; and when this drops below 400 lb/sq in it automatically disengages under spring force. The pilot then moves the surface by the direct mechanical link through rods, jack valve and body.

When power is selected for ailerons or elevator it is possible for the pawls to fail to engage the slots and simply to clamp the piston rod. Warning doll's-eyes in the cockpit are arranged to show proper engagement by changing from white to black only when the pawls have gone fully home. If the latter simply clamp, the pilot has the positive indication of a white doll's-eye and in this case the controls will revert to manual when the selector switch is released. The misalignment can be remedied by applying a hefty push to the stick to slide the piston past the pawl until the slot is engaged. When such a situation arises during re-engagement in flight, the necessary stick-rocking can be accomplished without producing untoward aircraft responses.

The doubling of mechanical advantage when the ailerons are manually actuated is achieved by varying the length of a telescopic lever in the control-rod circuit. Spring pressure keeps the lever short, thereby providing greater mechanical effectiveness for manual flying, while hydraulic system pressure is applied to lengthen it when power is in use. When loss of hydraulic power automatically allows the lever to shorten again, only half aileron-travel is available to the pilot; but this does not additionally hamper

Hawker Hunter
Fighter Bomber . .

and the Hunter
Two-Seater

are both equipped with

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and 'Maxaret' Anti-Skid
Units

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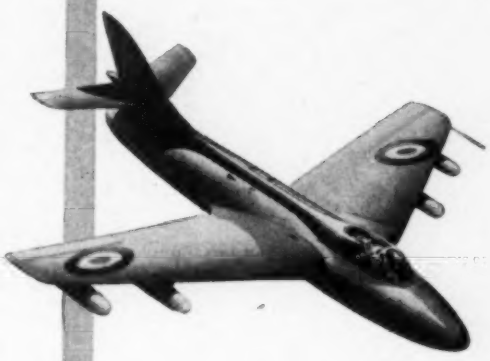

au/609

Mk VII Hawker Hunter in flight. 3M Sealers perfectly withstand vibration, structural flexing, thermal expansion and contraction and rapid changes in extremes of heat and cold.

Cabin sealing by pressure gun applicator

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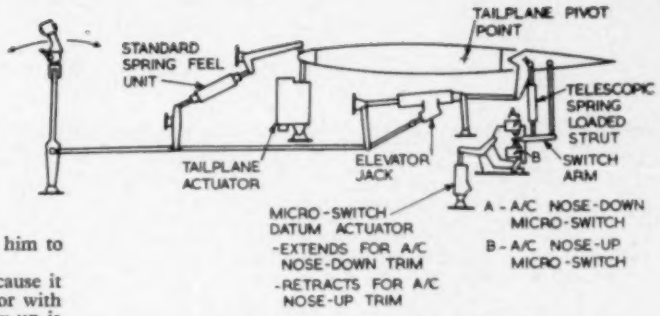


Tailplane and elevator control linkages, showing layout of tailplane follow-up and trimming systems.

HUNTER F.6 . . .

him, for aerodynamic loads are in any case too high for him to achieve full deflection.

The horizontal tail-control is rather more complex, because it involves a combination of hydraulic fully-powered elevator with electrical follow-up and trimming of the tailplane. Follow-up is achieved by a pantograph linkage from the elevator making contact with micro-switches which control the Rotax motor changing tailplane incidence. Consequent movement of the tailplane adjusts the position of the micro-switch datum to relieve the switches. These are also separated, so that the elevator will move one or two degrees before the linkage contacts a switch. The result is that fine control-adjustments, e.g., during formation flying, are made with elevator alone, while tailplane follow-up occurs with the larger movements needed during manœuvring at transonic or approach speeds. The "neutral" zone also avoids tailplane hunting.

Feel is provided by a standard telescopic spring unit connecting the pilot's control rods and the leading edge of the tailplane. The neutral or trimmed position is therefore reached when the elevator is substantially in line with the tailplane; and stick force remains directly related to stick movement regardless of speed. Overstressing is avoided by jack stalling. A centring effect is provided by a steepening of the rate curve near the neutral position.

Trimming is effected quite simply by an electric actuator which, moving simultaneously with the tailplane actuator, alters the datum of the micro-switches controlling tailplane follow-up. The pilot's control for this purpose is a sliding switch on the top of the control column.

As the Hunter control system is a mixture of hydraulic and electric components, and has many electro-hydraulic elements, the consequences of failure or malfunction of either electric or hydraulic supplies or components can be complex. Careful study of the very clear Hawker technical publication on the subject makes clear the various combinations with which a pilot might have to deal. For the purpose of this description some of the remoter intricacies may be omitted.

The basic stand-by is, of course, manual reversion, which occurs automatically; and hydraulic accumulators in the tail and aileron circuits (respectively at 1,575 and 900 lb/sq in) can provide several full control cycles to allow establishment of trimmed conditions for manual flying. Control forces are then very heavy, particularly on the ailerons, but a landing in this condition is perfectly feasible and is a standard training exercise. The tailplane follow-up will in any case continue to operate, though it may sometimes be better to switch it off. For practice in manual flying, power is switched off by closing the electrically actuated cocks governing oil supply to the servos.

In the event of electrical failure and a need to revert to manual control, a stand-by battery can be used to close these cocks. An engine windmilling after a flame-out will supply enough hydraulic pressure to provide adequate powered control, but in most such cases the pilot is recommended to revert to manual before landing. Prior to reversion it is also highly desirable to adjust the tailplane to an angle suitable for trimmed flight at a moderate airspeed and Mach number in order to avoid sudden and heavy out-of-trim stick loads at the moment of disengagement. In the event of tailplane actuator main-motor failure, a second motor integrally mounted with the jack, can be brought into operation. Opening of the safety cover which protects the switch provided for this purpose automatically cuts the main motor out of circuit.

The horizontal tail control is now such that accurate gun-sight tracking is possible at all speeds. At trans- and supersonic Mach numbers the tailplane is the most effective element and its rate of follow-up to the elevator will allow application of g at a rate of about 0.5 g/sec. Stick forces per g are satisfactory, although for high I.A.S. they may feel a little light. Stick forces which vary primarily with stick movement rather than with speed are a noticeable feature of the control system, but in this case the effect is not disconcerting.

Hydraulics. In the Hunter, hydraulic power is used to operate undercarriage, wheel brakes, flaps, airbrake and the aileron and elevator Hydroboosters. The main supply is drawn from a reservoir, located in the centre fuselage, through a Micronic filter and into either the main engine-driven pump or a hand-pump located in the engine bay. The latter pump can operate any of the services except the airbrake but is not available to the pilot in flight.

The engine-driven pump is a Dowty Vardel two-stage unit producing a working pressure of 3,000 lb/sq in, measured by a gauge in the cockpit. If pressure falls below 600 lb/sq in a warning light glows and an audio tone is fed in to the pilot's earphones. A push-switch is provided to reduce this note if required.

Emergency actuation of undercarriage and flaps is by compressed air at 2,000 lb/sq in from two spherical bottles mounted immediately behind the ejection seat. Related pressure-gauges are located on the port cockpit console. Emergency air enters the primary hydraulic system, but does not affect the powered-control circuits if the normal selectors are in the correct position for the movement required. Oil displaced by the air is dumped overboard.

Emergency wheel-brake operation is by oil at 750 lb/sq in stored in two Dunlop accumulators mounted in the nosewheel bay. Most of the valves in the system are electrically operated. The majority of the hydraulic components are supplied by Dowty.

A single jack moves each mainwheel leg and the three cover doors which are mechanically linked to it. Mechanical sequencing valves then control the operation of the jack which closes the inboard door and engages a mechanical up-lock for the whole unit. An equivalent arrangement obtains for the nosewheel. A large spigot in each mainwheel well locates the leg in the retracted position by engaging a hole in the wheel axle.

Undercarriage-mounted micro-switches cut out the retraction circuit when the weight of the aircraft is on the wheels, but this precaution can be overridden by the pilot and retraction effected in emergencies where a ground run must be converted into a slide.

An electric switch with "up," "down" and six intermediate positions controls hydraulic flap extension. Synchronization of the two split flaps is achieved by interconnected idling jacks working at 500 lb/sq in, one at each flap. Pressure balance is automatically reset after each retraction. The flaps are intended for use as airbrakes, but stressed for normal descents only, while the airbrake proper can be used without limitation and is controlled by a sliding switch recessed in the head of the engine-control lever. In order to prevent the airbrake scraping on landing, a micro-switch on the undercarriage breaks the circuit on extension and causes the brake to retract automatically. A doll's-eye in the cockpit turns white when the airbrake is extended.

The Dunlop wheel-brakes are operated by a hand-grip on the control column, connected with a relay valve on the rudder pedals to allow differential application for steering. A triple-reading gauge shows main supply and individual break pressures. Skidding of the wheels is prevented by Dunlop Maxaret units at each disc brake. Gauges on the port console indicate the pressure of the two emergency-braking accumulators.

Electrical Installations. Electrics intrude into virtually every system of the Hunter, for almost all remote control and indication is by electrical means. Though the ramifications of this system are therefore very considerable, the methods and techniques employed do not differ from the normal.

The main system is of the 28v, single-pole, earth-return, voltage-regulated type, the supply coming from two wide-speed-range generators mounted on the accessory gearbox in the engine bay. They are connected in parallel and stabilized by two 24v, 25 A-hr Varley-type batteries which are parallel-connected to give 50 A-hr. Voltage regulators for the generators are mounted in the radio bay, where the batteries are also located. For ease of testing and servicing, the earth leads have been concentrated at a number of points conveniently located throughout the airframe.

Flight instruments, engine-temperature control, radio and radar-ranging all require A.C. at 115v, 400 c/s, three phase; and this is supplied by two inverters mounted on the cabin floor aft of the ejection seat. No. 1 inverter is the main source for flight instruments and engine temperature control, while No. 2 acts as a stand-by and as the primary supplier for radar-ranging. If No. 1 fails, No. 2 automatically takes over and sheds the radar-ranging load. As with most such arrangements, a test switch is provided so that the change-over may be checked by the pilot. A separate low-voltage inverter serves the gun-firing system; and a 1,600 c/s single-phase auxiliary inverter is also provided for the radar ranging.

Fuel. Internal fuel tankage in the Hunter F.6 is distributed in each wing, in the forward fuselage and round the exhaust section of the engine, immediately aft of the fuselage break. The inboard universal pylons under each wing can accommodate either Bristol 100-gal plastic drop-tanks or Hawker 230-gal metal drop-tanks, while each outer pylon can take either a bomb or a further 100-gal tank. A very respectable fuel load can be accommodated when long ferry flights are required.

The whole system is divided into port and starboard sections,

HUNTER F.6 . . .

entirely separate from each other, their delivery to the engine being balanced by a Rotol vane-type fuel-flow proportioner. The front fuselage tanks are the master receivers, collecting fuel from all the other tanks; and they contain recuperators for inverted flight and S.P.E. electric booster pumps. Vapour-release valves ensure that air pressure from fuel boiling or rapid climbs will not block transfer from other tanks.

Fuel is passed from tank to tank by engine-bled air which is regulated to a constant pressure by a Hymatic reducing valve. The rear tanks first transfer their contents and, after low-level float switches have signalled them to be empty, the outer drop-tanks take over. The rear tank supply pipe is then automatically closed and these tanks isolated. Transfer continues through outer to inner pylons, through the groups of wing tanks and into the master receivers. As soon as a drop-tank is jettisoned, its air and fuel pipes are automatically united so that the continuity of the transfer sequence is preserved.

Magnetic indicators in the cockpit show the position of each fuel cock and, although the whole system is normally entirely automatic in operation, overriding switches are provided. In addition, a warning light will show failure of fuel-transfer pressure; and all but the master tank gauges will thereafter immediately read empty. The pilot then has a quantity indication only for the fuel which still remains usable to him, namely that in the master tanks. Failure of one pump, indicated by warning light in the cockpit, causes the other to be switched to high-speed working, thus maintaining supply of fuel to the engine. Indication of both pumps being inoperative—and therefore of low pressure in the delivery line—is also given by warning light. The light will go out when throttle setting is sufficiently reduced to allow the engine to run on the remaining pressure.

The throttle lever in the cockpit operates the high-pressure cock during the first part of its movement forward from the rear stop, a 5-deg segment being reserved for the idling setting. A micro-switch is included to light the undercarriage warning light if the throttle is closed to idling with the wheels up. The low-pressure cock is operated by a separate lever further aft on the port console.

Smiths-Waymouth capacitance gauges are fitted in each internal tank, the total contents per side being registered on separate gauges in the cockpit. The whole fuel system is portrayed on the starboard console in diagramatic form, gauges giving tank contents, white lines representing fuel pipes and magnetic indicators showing positions of cocks. Control switches are beside the magnetic indicators; and warning lights are suitably placed. Contents of drop-tanks (which drain after the rear tanks and before the wing tanks) are not indicated.

Icing, which may occur in the main engine-fuel filter because of small amounts of water suspended in the fuel, is detected by a Teddington Controls differential-pressure switch which senses any excessive pressure-drop across the filter. When this occurs, a Plessey priming pump is automatically started by a relay to pump alcohol from a stainless steel one-gallon tank through a 1/16in-diameter nozzle into the main fuel delivery pipe.

Normal refuelling is under pressure through an Avery-Hardoll 1.5in nozzle located in the port wheel bay. Switches and controls are set beforehand to ensure correct filling and to prevent back-flow and over-pressure. Fuel is fed simultaneously to fuselage and wing tanks; and it passes through the latter to the drop-tanks, if such are fitted. Pressure-relief valves are incorporated in most tanks to help control the fuelling operation. The tanks can also be emptied on the ground through the refuelling connection by setting a Saunders valve reached through the engine-access panel. An external air supply of at least 10 lb/sq in is connected to the tank-pressurization system and fuel is thus transferred normally to the master tanks. Suction from a bowser or the master tank booster pumps can bring the fuel overboard to empty the tanks completely.

The fuselage tanks, made by both Marston Excelsior and Fireproof Tanks, are flexible rubber bags with madapolam vulcanized on the outside and covered with three layers of glasscloth finished with fireproof lacquer. Those in the wings are again flexible rubber bags, but have nylon net vulcanized on the outside and covered with fireproof lacquer. Wing and master tanks are introduced into their bays by long cords attached at their suspension points. The cords are pulled through holes in the walls of the bays and are then knotted and cut off short to hold the bags in. The recesses in which the knots lie are plugged with screw-caps. For the master tanks these caps are in the top of the fuselage; for the wing tanks they are behind the front spar and are accessible from the main-wheel bay.

Air Conditioning. Pressurization and air-conditioning of the Hunter cockpit follows what is now established practice. A bleed is taken from the final compressor stage of the Avon and passed through a series of cooling stages and controlling valves into the pressure cabin, the required pressure-differential being achieved by throttling two outlet valves from the cabin. The system is controlled electrically and, after being switched on, automatically builds up pressurization from 10,000ft upwards. Under certain flight conditions, and when pressure is switched off, a ram-air intake in the gun-camera sight tube admits fresh air directly into the cabin, through-flow being established by the simultaneous automatic opening of a dumping valve. If cabin altitude exceeds 38,000ft, or when manually selected by the pilot, an increased engine bleed supply is led directly into the cabin, providing a high flow of virtually uncooled air. This feature is particularly necessary to prevent canopy misting when descending rapidly from very cold upper regions.

A conventional rubber seal closes the gap between sliding canopy and coaming, a differential of 8 lb/sq in between cabin and seal pressures being automatically maintained by air drawn from a point well upstream in the conditioning system. Inflation and deflation are controlled by sequence switches and solenoids connected with canopy actuation. A delay is included in the opening sequence to allow partial deflation before the canopy begins to move; and initiation of the jettisoning sequence also causes deflation.

Air initially passes from the compressor bleed through a pre-cooling stage consisting of a Marston Excelsior heat exchanger cooled by ram air drawn from the starboard engine intake trunk and dumped through an exit near the dorsal spine. This pre-cooler is automatically by-passed when either fully hot or flood flow is selected. Further cooling elements consist of a refrigerator made up of a Godfrey boot-strap compressor-turbine unit and heat exchanger, the latter taking cooling air from the port intake trunk.

Having switched the system on, the pilot is able to select on a dial automatic control of a temperature between 5 deg C and 30 deg C. He may also select an increase in heat or cold without automatic control and, finally, flood flow. The control unit is a Teddington magnetic amplifier and sensing elements based on a Wheatstone bridge, monitoring an electrically actuated regulating valve. This in turn governs the proportions of hot air from the pre-cooler and cool air from the refrigerator which are fed into the mixing chamber and through a water extractor, into the cabin via a non-return valve. In the fully hot setting, pre-cooler and refrigerator are cut out, but in the flood setting the flow-control valve and normal ducting as well are largely short-circuited, though the water extractor remains in circuit.

Conditioning air is distributed in the cabin by a series of spray pipes along the lower edges of both canopy and windscreen; and

HUNTER VARIANTS, 1951-1958

Prototypes

WB 188 1st prototype P.1067. Flew July 20, 1951. Later modified to Mk 3 standard with reheat and set world speed record. Then fitted with lateral airbrakes.
WB 195 2nd prototype. A Mk 1 with gun pack. Flew May, 1952.
WB 202 3rd prototype, with Sapphire. Became Mk 2. Flew November 30, 1952.
XF 833 P.1099 prototype, Mk 6. Flew 1954. Later used for drag 'chute trials. First 20 Mk 1s used for development of equipment and installations.

Production Prototypes

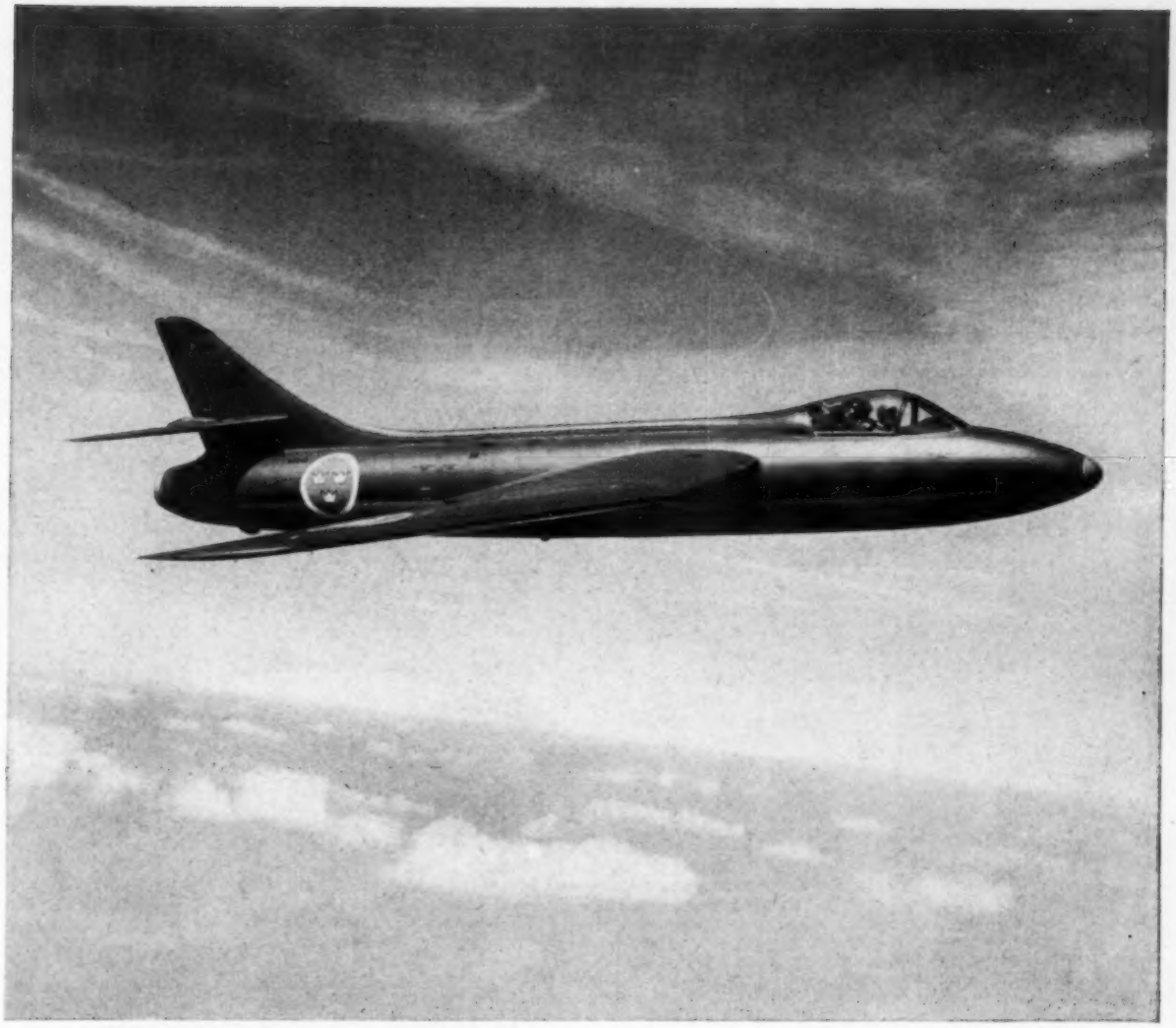
WN 888 1st production Mk 2, built by Armstrong Whitworth, October 1953.
WT 701 1st production Mk 4, with Avon engine.
WV 385 1st production Mk 4 with later Avon.
WN 954 1st production Mk 5, built by A.W.A.
WW 592 1st production Mk 6, with Avon 200 series. First flew in March 1955.
XJ 615 1st two-seater P.1101, based on Mk 4. July 1955.
XJ 627 2nd two-seater P.1101, based on Mk 6.
XL 563 1st production Mk 7, based on Mk 4.
XF 373 1st production Mk 6, built by A.W.A.

Research Developments

WT 780 Mk 4 with ram-air turbine in rear fuselage for elevator emergency supply.
WT 562 Mk 1 with one-third-span flaps.
WT 566 Mk 1 with first production airbrake.
WT 568 Mk 1 with saw-tooth wing (by Boscombe Down).
WT 571 Mk 1 with area rule bulges (by R.A.E.).
WT 656 Mk 1 with blown flaps (by R.A.E.).
WN 955 Mk 5 with Armstrong Siddeley Sapphire 200 series. Mk 6 standby.
WN 891 Mk 2 Arctic trials at C.E.P.E., Canada.
XF 310 Mk 4 with Fireflash, used by Fairey Aviation.
WT 780 Mk 4 with five-camera F.R. nose.
XF 970 Mk 4, tropical trials at Idris.
WW 594 P.1109A. Mk 6 with long nose. Aerodynamic tests and to R.R.E. for radio tests. Two guns not fitted.
WW 598 P.1109A as above for aerodynamic tests, less two guns.
XF 378 A.W.A. Mk 6 seen with long nose and carrying Firestreaks.
XG 131 Fitted with tip-tanks in 1956, but reverted to normal and supplied to a squadron as a Mk 6.
XF 379 Mk 6 by A.W.A. with lateral airbrakes.

Foreign Marks

Mk 50 Swedish Mk 4.
Mk 51 Danish Mk 4.
Mk 52 Peruvian. Ex-R.A.F. Mk 4.
Mk 53 Danish Mk 7, based on Mk 4.
Mk 56 Indian Mk 6.
Mk 58 Swiss Mk 6
Mk 66 Indian Mk 7 based on Mk 6.
Iraqi Hunters are Mk 6s taken from R.A.F. squadron service.



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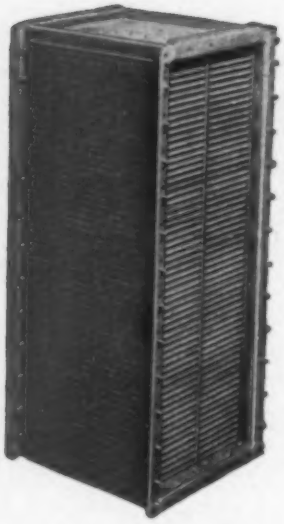

We design, manufacture and supply heat exchangers for many purposes in both aluminium alloy and stainless steel. This particular example is for the Vickers Viscount's anti-icing system. Similar units are supplied for the Fokker Friendship and the Bristol Britannia.

This thermal blanket is in refractory fibre cased in .004 inch (.1016 mm) stainless steel. It was made-to-measure and is extremely light, the dimpled construction being responsible for its great strength. Specified for Rolls-Royce and Armstrong Siddeley jet and turbo-prop engines. Approved by the A.R.B.

High pressure fuel-cooled oil-cooler for high performance gas turbine engines. This unit is used in the Armstrong Siddeley Sapphire S.A.7.

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HUNTER F.6 . . .

some air is discharged from the cabin near the feet. External connections are fitted for testing the pressure cabin, hood seal-inflation and the cabin-pressure controller. Air dumped from the Normalair main cabin-pressure control valve on the forward bulkhead is collected in a shroud and used to cool the radar containers.

Oxygen. The oxygen system consists of a standard Normalair demand regulator which passes to the pilot's mask the correct mixture of air and oxygen for all heights according to his breathing rate and strength. Gaseous oxygen is stored at 1,800 lb/sq in in two 750-litre cylinders mounted on the starboard side between frames 4 and 6 and retained by wing-nut-tensioned straps and a cable. In addition to the functioning indications of the regulator, the pilot has a total pressure gauge, both these units being mounted on the starboard console. An emergency supply of 55 litres, contained in a bottle stowed in the dinghy pack, can be selected by pulling a toggle; and it is automatically initiated when the seat leaves the aircraft. The main cylinders may be recharged *in situ* from a connection in the nosewheel bay.

Ejection Seat. The Hunter is fitted with either the Martin-Baker Mk 2H or 3H ejection seat, both being fully automatic and suitable for use at any height above 50ft. Both seats have the Irvin back-type parachute and duplex drogue-deceleration system, the main difference between the two lying in the fact that the Mk 3H has leg-restraining harness instead of thigh guards. In both cases the pulling of the firing blind first initiates the jettisoning of the canopy and then ejects the seat after a one-second delay. The canopy may nevertheless be jettisoned manually without causing ejection.

Anti-g System. Provision is made in the Hunter for an anti-g suit and pilots are ordered to wear this clothing for all normal operational flying. Air pressure for the suit is stored in two Dunlop spherical air bottles of 110 cu in capacity, each at a pressure of between 1,800 and 2,000 lb/sq in, mounted behind the ejection seat immediately above the emergency-air bottles for flap and undercarriage operation. A common ground-connection serves for the charging of all four.

Air is automatically fed into the g-suit in proportion to the amount of g being exerted after the pilot has turned the system on with the Hymatic selector valve. It passes through a Dunlop air filter and a Palmer pressure-reducing valve before reaching the Hymatic anti-g valve. On this there is a test button with which the functioning of the system may be verified or the suit inflated intermittently in order to relieve pilot fatigue. A pressure gauge above the controls, which are on the starboard console, indicates the remaining pressure in the bottles. The flexible lead from the system is clipped to the ejection seat and a further lead is connected to the suit itself. Quick-releases effect immediate disconnection on baling out.

ALLISON T61

FORMERLY known only by its company designation of Model 550, the T61 is the military designation of the new 5,500 e.h.p. two-spool turboprop by the Allison Division of General Motors. The new designation confirms that the engine has military backing. It is already running, and is scheduled for late-model Electras and for such projects as the Lockheed W2V/1649 successor.

LIQUID-COOLED BRAKES

UNDER the sponsorship of the U.S.A.F. and Air Research and Development Command, B. F. Goodrich Aviation Products have developed a liquid-cooled brake for aircraft. The cooling liquid collects heat from a disc-brake unit and transfers it to a heat exchanger, lowering the heat of the brake by as much as 1,500 deg. The weight of the prototype unit is about the same as that of a standard brake, but this could be reduced if some components were simplified.

SURVEY IN SIERRA LEONE—

WORK is now in progress on an airborne geological survey of 4,000 square miles of southern Sierra Leone designed to assess the mineral resources of that region. The task is being carried out by Canadian Aero Service, Ltd., using aircraft supplied by Derby Aviation, Ltd., and fitted with a magnetometer and a scintillation counter. Work on the ground in the heavily forested area involved would be difficult and slow. The flying was to take some five or six weeks and cost about £28,000, the money being supplied by the United Kingdom Government under a Colonial Development and Welfare grant.

—AND IN BOLIVIA

SIX aerial-survey contracts covering approximately 60,000 square miles of Bolivian territory have been signed between a number of international oil companies and the Canadian Hunting group. The work includes aerial photography, photogrammetric mapping, the preparation of mosaics, astro control, airborne magnetometer surveys and their interpretation.

The aircraft used will comprise one B-17 and two Hudsons of Kenting Aviation, and the survey personnel will come from The Photographic Survey Corporation, Ltd., and Aeromagnetic Surveys, Ltd. In charge of the operation is Mr. Robert Brocklebank, whose headquarters will be at Cochabamba, central Bolivia.

NEW ASBESTOS LAMINATE

TURBOJET compressor blades, and rocket parts subjected to direct blast, are among the applications suggested for the new "Dilecto" laminates and "Celoron" moulded parts produced by the Continental-Diamond Fibre Corp, of Newark 107, Delaware, U.S.A. It is stated that the material will withstand temperatures of up to 3,500 deg F for short periods.

Raw materials for laminated parts are felted asbestos made from extra-long-staple non-ferrous fibre, impregnated with phenolic resin or varnish. Mouldings require a different form of asbestos, suitable for the moulding process. High mechanical strength is claimed for the new product, which can be fabricated by normal production methods, including punching, turning, threading, tapping and milling. It is also stated that mechanical strength is only slightly affected by subjection for limited periods to very high temperatures, and continuous operation at 500 deg F is quite practicable.

Other properties claimed include a high modulus of elasticity, high impact strength, low porosity, effective chemical and water resistance and good dimensional stability. Parts under test were subjected to temperatures of up to 350 deg F in wet and dry steam with little change in dimensions or mechanical strength, and immersed in boiling water for two hours with negligible absorption.

"FLIGHT" PHOTOGRAPHS

MANY of the photographs reproduced in *Flight*, i.e., those taken by our own photographic staff (as indicated on publication) are subsequently available in the form of high-quality prints. Prices are as follows (dimensions given in inches): $5\frac{1}{2} \times 3\frac{1}{2}$, 1s 4d (glossy or semi-matt, unmounted), or 2s (toned sepia, unmounted); 6×4, 2s 6d or 4s; 8×6, 3s 6d or 5s 6d; 10×8, 5s or 7s 10d; 12×10, 6s or 9s 8d; 15×12, 9s 6d or 13s. Larger prints can be supplied in special sizes to order (semi-matt finish only) from 20×16 at 13s 0d up to 40×60 at 6 gns.

Also available are a postcard series, totalling over 200, depicting both historic and modern aircraft of the R.F.C., R.N.A.S., R.A.F. and Fleet Air Arm. Complete lists of the series are obtainable on application. Prices are 7d each card, or $6\frac{1}{2}$d each for quantities of a dozen or more. One view only—in most cases a good three-quarter front or side—is available for each aircraft type. Also available as postcards, at the same prices, are reproductions of general-arrangement drawings of some 20 British aircraft that have appeared in our "Aircraft Intelligence" pages.

***MASTER PILOT:** Appropriately uniformed and decorated for the occasion, Capt. A. N. Solyanik, Master of the Russian Whaling Fleet (left), acquaints Mr. Walter Nash, Prime Minister of New Zealand, with a Soviet whale-spotting helicopter. The occasion was a visit by the whale factory ship "Slava" to Wellington.*

Straight and Level

THE Conservative Member for Yeovil, Mr. J. W. W. Peyton, asked the Minister of Supply in the House of Commons last week: "Does not my right hon. friend agree that this practice [American aircraft manufacturers buying back old aircraft from customers who order new ones] is an example of thoroughly short-sighted, cut-throat competition of the worst kind?"

I was so staggered when I read this in *Hansard* that I just blinked and blinked and blinked. Since when was the trading-in of old goods for new unfair competition? When Mr. Peyton buys a new car does he shun part-exchange as the "commerce of Bedlam," as he went on to call it? Does he accuse B.O.A.C., who have just had a good offer from Boeing for most of their old Strats. (a deal which I imagine is not entirely unrelated to the Corporation's purchase of 707s), of being a party to "cut-throat competition of the worst kind"?

As for the suggestion that H.M. Government should "make representations to the U.S. Government"—can you imagine anything more pathetic? "I say, do you mind, you're *hurting*." You do not meet a challenge like this by pleading with your opponent not to punch too hard.

The Minister, to my dismay, appears to agree with Mr. Peyton. At least, I can put no other interpretation on his reply, which was: "It would be the hope of the Government that all other governments would ensure fulfilment of all international obligations of fair trading."

It would be the hope of British aircraft salesmen that these sentiments, which suggest that the world owes our aircraft a living, are not taken to reflect their own.

● What is a cartel? Some people would say "I.A.T.A." And in saying it they would incur the displeasure of Sir William Hildred, I.A.T.A.'s director-general, and the mildest of men.

Why does the word cartel make him so cross? Because a cartel, the economists would say, is by definition a group of suppliers who restrict price *and* output. I.A.T.A., for all its price-fixing, does not restrict output. The airlines can put as many ton-miles into the sky as they think they can sell.

All right then, I concede that I.A.T.A. is not a cartel. But I can tell you something that is—airline pooling agreements. By these agreements price *and* capacity are restricted, revenues are shared out, competition is eliminated, and a good old monopoly is created. The airlines do this, they say, to give the public better service. I think they do it to make things easier for themselves.

● Here is the fourth in my Someone Had To Do It series: Herr Hubertus Weiss, of Ulm-Soeflingen, Germany, is seen with the model of the *Graf Zeppelin* which he has constructed from two million matches. It took him 11,000 hours.

I salute him, as I saluted (1) the Frenchman who spent 30 years applying the principles of beetle-flight to aeronautics; (2) the American who plans to

fly non-stop round the world in a home-made motorized glider; and (3) the civilian (another American) who built himself a Shooting Star out of spare parts.

I do not mean you to laugh at these men; but if you do, remember that they are the kind who thrive on mockery, which they regard as a sign of the mediocrity they shun.

● Lots of people are working in the field of superconductors. These are usually metal alloys which, when depressed to something colder that 20 deg K (i.e., below minus 253 deg C), lose their electrical resistance entirely. Superconductors may become valuable where electrical signals of exceedingly small strength have to be employed, and such signals can be met in the airborne systems of long-range ballistic missiles. It is a happy chance that the liquid-oxygen tank of an ICBM is an excellent starting-off point for lagging a superconductor, since this reduces the ambient temperature to −183 deg C to start with.

However, this very low temperature causes numerous problems in the design and operation of ballistic missiles, and one of the most insoluble—in both senses of the word—is the problem of preventing the performance of the weapon from being impaired by the layer of frost which forms after the liquid-oxygen tanks have been filled. An Atlas-firing in heavy rain does not, at present, seem feasible.

● I am taken to task by a reader—Mr. H. Ginsberg of Wembley—for un-British activities. He writes to say that *Straight and Level* for April 25 "had a *whole* 18 lines in which no reference was made to American aviation."

He asks whether things of interest never happen in the rest of the world—"even in this country."

Yes, they do. If Mr. Ginsberg cares to measure the American content of these pages to-date he will find that it amounts to just about 40 per cent. (I have just made a quick count to reassure myself.) As for the April 25 edition, if he counts the number of lines again he will find that 96, not 18, contained no reference to our dreaded rivals. They came out with 90 lines.

But I acknowledge the spirit of his accusation, which cannot fully be answered with editorial statistics. It so happens that 40 per cent of the things which interest me (I'm talking about aviation) are American. I do not know what this proves: all I know is that it is against the Americans that we measure 90 per cent of our successes and failures.

● Keep your airliners clean, and keep them dry. This is the moral of one European airline's estimate that its airliners pick up weight due to dirt and moisture at a steady annual rate of one quarter per cent of basic weight. After five years at this rate, a Viscount (say) could lose payload equivalent to three passengers, a thought which becomes all the more salutary when you realize that, *in addition*, modifications add weight which can account for a ten per cent decrease in payload over ten years. Design departments to make a note, please.

● It's a well-known fact that you can prove that a bumble bee cannot fly (largely owing to its excessive wing loading); but, so the story goes, the bee isn't aware of this so he goes on flying. John Yoxall (formerly *Flight's* chief photographer, and now manager of the Iliffe photographic department), who has been breeding these fascinating creatures for years, is at present engaged in developing high-aspect-ratio bees. He thinks, like M. Hurel, that they will carry more honey.

● I hear that the Blackburn Beverley has been investigated for the "Dunkirk" rôle. Out came the seats, in trooped 428 soldiers. The Royal Air Force would uplift 300, conditions being described as "no worse than the average cocktail party."

ROGER BACON

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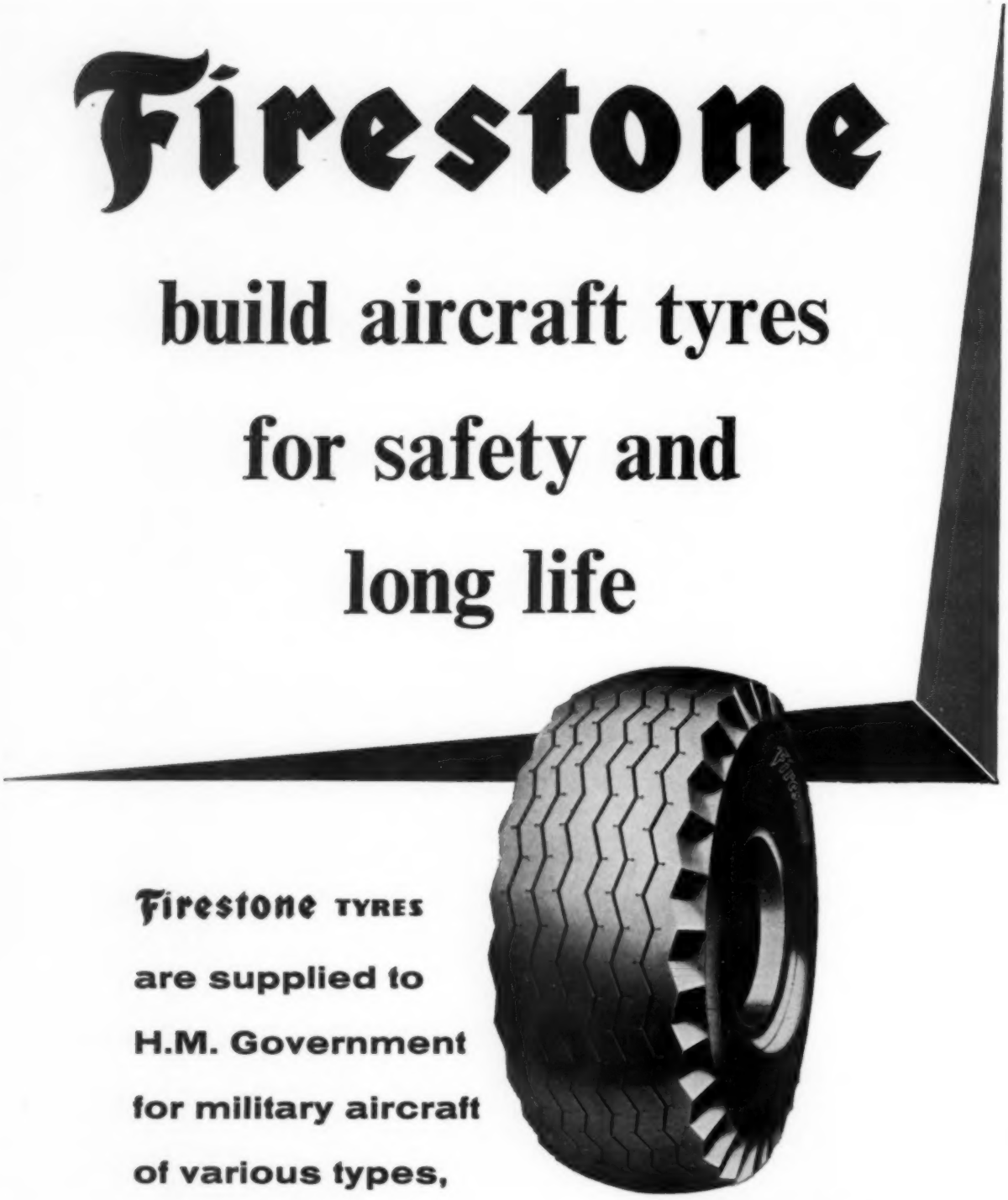

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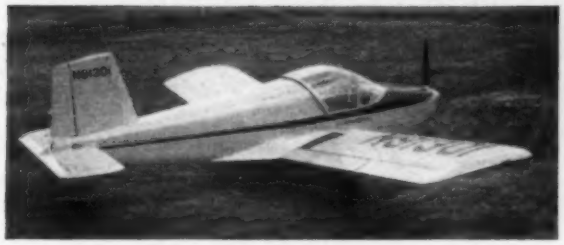


International quartet of light sports aircraft: (clockwise, from top left) Rollason Bishop conversion of the Tiger Moth, seen at Kidlington; closed-cockpit version of the Druine Turbulent made by the German Stark company and shown last week at Hanover; Stits-Trefethan Playboy built by Joanne Trefethan of Lomita, California; and Thorp Skyscooter, designed and built by John W. Thorp of Burbank, California.

CLUB AND GLIDING NEWS

WHEN all the committees have been held, and all the talking is over, it is still the people who fly who do the most good for the flying club movement. Active pilots all, members of the Tiger Club did some gentle crusading at Sywell last Sunday in the competition for the de Havilland Trophy—a silver Tiger Moth given by the de Havilland organization for the best aerobatic performance by a pilot of less than 250 light-aircraft hours. Six pilots competed for this, and three "experts" (with more—in some cases much more—than 250 hours) vied for a bottle of champagne.

It was a dark-glasses, tea-on-the-lawn day at Northampton, with a warm sun, a gentle breeze and acres of fresh, green turf to soothe away the cares of the daily round and to add enjoyment to the gentle post-prandial cavorting of the Tigers. And a formation display, a demonstration by two Turbulents and a two-men-and-a-girl formation drop by the British Parachute Club added variety to the scene. Three of the novices and all the experts elected to fly "The Bishop." Mr. C. Nepean Bishop's beautifully modified single-seat Tiger G-APDZ. In the under-250 class the inverted fuel system was not used by every competitor. When it was, the Bishop gladdened many a heart with its sparkling performance, and maestro Bishop and Bob Crowhurst (who won the champagne) showed that this Tiger will be something to reckon with at Coventry this year, although bunts and flick manœuvres seem to be outside its present range. Commentator David Ogilvy was *quite* impressed.

Of the novices, Hancock was outstanding; others had something to learn about keeping straight in manœuvres and positioning. Results were as follows: G. Hancock, 87 pts; S. W. Brant, 65; C. M. Labouchere, 60; J. Wardley, 58; Miss M. McKellar, 46; D. Boddington, 42; J. Piercy, 38.

RHOOSE Airport, Cardiff, will be the site of next month's national rally of the Popular Flying Association, organized in conjunction with the Glamorgan Flying Club. The rally begins with lunch and a *vin d'honneur* at the airfield on Saturday, June 14, followed that afternoon by an informal air display. A dinner dance will be held at the Angel Hotel, Cardiff, the same evening, and further informal flying will take place at the airport on the following day. Closing date for entries is May 31.

THE Czechoslovak Zlin Z.226 Trener, well-known in this country for its aerobatic abilities as demonstrated at Baginton, is now being delivered to the Soviet Union for use by the aero clubs there. Up to the end of last year machines of this type had been sold to ten foreign countries. In Russia, Treners will be used "for the training of picked pupils in high aerobatics."

ARRANGEMENTS have been completed between the governments of France and Switzerland to enable French and Swiss glider pilots legally to fly across the frontier and land at non-customs airports—or, indeed, non-airports—in the other country. The pilot has to complete a special authorization form before take-off, and carry means of identification; after landing he has to contact the nearest police station. "No merchandise may be transported" the official announcement states, "with the exception of personal effects, provisions and materials of navigation." It is hoped to extend the scheme later to other countries.

DETAILS of a number of teams entered for the World Gliding Championships have been announced by the Polish Aero Club. These confirm that the variety of aircraft to be flown at Leszno will be wide, and that the new standard class will be a particularly interesting event. In the United States team, Stanley Smith and Paul Bikle will fly Bréguet 901s, and Lyle Maxey a Jaskolka, in the open class; with Francis Compton flying a Mucha 100 in the standard class. Three Zugvogels are to be entered by the Swedish team, one in the open and two in the standard category. Austria is flying four Musger Mg-23s, while Yugoslavia's open-class entry comprises two of the exotic all-metal Meteors. The veteran Olympia 2 (two machines) is represented in Denmark's entry for the standard class, and Hungary has included two Siraly 2 sailplanes for the open class. Neither the Polish nor the Russian team has yet been announced.

The Polish Aero Club states that seven countries, in addition to Poland, have stated an intention to use radio communication during the championships. Formalities relating to foreign radio operation in Polish territory, the club's information bulletin states, have been relaxed by the Polish authorities. An incidental item of news is that special stamps are to be issued on the occasion of the championships by the Polish Post Office.

FLYING in a Sky sailplane from the Derby and Lancs Gliding Club's site at Camphill, Derbyshire on April 27, Bill Elrington achieved a Diamond goal flight of 197 miles to Lympne Airport, Kent. On the same day and from the same site, Harold Corny flew a Gull 4 to Mendelsham, near Ipswich, a distance of 140 miles.

FORTHCOMING EVENTS

May 7-17. Mechanical Handling Exhibition, Earls Court, London.
May 9. Helicopter Association: "Canadian Research in the Field of Helicopter Icing," by J. R. Stallabrass.
May 9-11. Channel Islands Aero Club: International Air Rally, Jersey Airport.
May 14. Kronfeld Club: "1958 World Gliding Championships," by Ann Welch.
May 15. R.Ae.S.: 46th Wilbur Wright Memorial Lecture: "Automatic Flight," by G. W. H. Gardner.
May 16. Institute of Navigation: "Principles of Inertial Navigation Systems," by E. W. Anderson.
May 21. Kronfeld Club: Debate, "The Golden Age of Gliding has now Passed."
May 24-26. Belgian Aero Club: Brussels Exhibition Rally.
May 24-26. Fréjus-St. Raphaël Aero Club: Provence Wines Rally.
May 25-June 1. Aéro Club de l'Ouest: Angers Gliding Competition.
May 25-26. S.M.A.E.: National Model Contest, R.A.F. Waterbeach.
May 26. Tiger Club: Air Races, Sandown, I.o.W.
May 26-27. Canadian Aeronautical Institute: a.g.m., Toronto.
May 28. Kronfeld Club: "Cambridge University Gliding Club," by John Pringle.
May 29. The Royal Society: "The Institute of Aviation Medicine," by G/C. W. K. Stewart.
May 29-June 1. R.Ae.C.: International Invitation Rally, Shoreham.
June 1-3. Aéro Club de France: Helicopter Rally.
June 4. Kronfeld Club: Lecture by David Ince.
June 6. Helicopter Association: "Turbine Helicopters," by D. L. Hollis Williams.
Sept. 1-7. S.B.A.C. Display and Exhibition, Farnborough.

"Flight" photographs

Air Marshal Sir Richard Atcherley, A.O.C.-in-C. Flying Training Command, meets competitors for the Wright Jubilee Trophy—awarded annually for aerobatics by selected instructors from each jet F.T.S. and from Cranwell—at Little Rissington on May 1. He is shaking hands with F/L. D. F. Moffatt of the R.A.F. College. In the right-hand picture is the winner, F/L. R. E. Holloway of No. 5 F.T.S., Oakington, in the cockpit of his Vampire T.11 with the trophy.

SERVICE AVIATION

Showing the Flag

FOUR R.A.F. Canberras, two from No. 58 Sqn. at Wyton and two from No. 59 Sqn. at Geilenkirchen, flew to British Honduras last week to be present during the visit of Princess Margaret. This move was organized within 24 hours, the Colonial Office having requested it on April 29 and the aircraft reaching their destination the following day. The detachment was under the command of W/C. G. H. Westlake, C.O. of No. 58 Sqn., and was supported by a Comet of No. 216 Sqn.

Senior Postings

FROM next Monday (May 12) A. Cdre. H. J. Maguire, successively Director of Tactical and Air Transport and of Fighter and Theatre Air Forces since December 1956, is to be S.A.S.O. at No. 11 Group. Recently announced also is the appointment of G/C. A. Pyke as Senior Technical Staff Officer at H.Q. Coastal Command with the acting rank of air commodore, after commanding the Central Servicing Development Establishment from mid-1956.

Farewell and Welcome

WITH the A.O.C-in-C. Home Command, the Vice-Chancellor, the Lord Mayor, the A.O.C. No. 64 Group and A.V-M. W. A. B. Bowen-Buscarlet among its principal guests, the Manchester U.A.S. annual dinner last Friday proved a notable send-off for S/L. J. F. Pinnington, who is relinquishing command after three years, and an impressive welcome for his successor, S/L. S. A. Harris. In particular the new C.O. would have noted the cordial relationship between the university and the R.A.F. As the bursar, Mr. R. A. Rainford, put it when responding to the toast of the guests: "I get a great kick out of meeting the U.A.S. One can't help being impressed by the youthful enthusiasm of the R.A.F." And on the other side, as expressed by A.V-M. H. V. Satterly: "I count it a privilege as a serving officer to propose a toast to your great university."

Air Marshal Sir Douglas Macfadyen said that the primary object of university air squadrons was to interest young men in, and to form an influential body of opinion favourable to, the R.A.F.—which still had a future though its front line was being reduced. He was delighted that the university squadrons were to continue, though there had been "a few snags" about this and in future they were going to have to be "a bit more particular" about who they took in.

The C-in-C. presented the Cheshire Trophy (for the best all-round cadet of the year) to P/O. D. Simmonds and the Campbell Trophy (for aerobatics) to P/O. J. Larcombe; he congratulated the squadron on winning the de Havilland Trophy for the second time and for doing more flying than any other similar squadron in 64 Group; and he paid partcular tribute to the work of S/L. Pinnington.

Similar appreciation of the retiring C.O. was expressed by the Vice-Chancellor, Professor W. Mansfield Cooper.

Moscow Attaché

NEXT month G/C. P. J. Sanders, who since mid-1955 has been Air Defence Staff Officer at SHAPE H.Q., is to take up the appointment of Air Attaché in Moscow with the acting rank of air commodore. He was Air Attaché in Belgrade from September 1948 to March 1951, and among his wartime appointments were the command of Nos. 92 (with whom he won the D.F.C.) and 264 Sqns.

Birmingham Modesty

DURING the past twelve months the achievements of Birmingham University Air Squadron were "modest." This was the assessment modestly offered by its commanding officer, S/L. B. E. Hogan, at the annual dinner on April 29. But he could report that they were runners-up for the Hack Trophy; that the airfield construction flight had "made great progress"; and that despite having been foreclosed upon by the landlords—the University and Castle Bromwich—the squadron had successfully settled down to flying at Shawbury.

S/L. Hogan was replying to a toast to the squadron proposed by Prof. A. P. Thomson, Dean of the Faculty of Medicine, who said that whatever the parentage of the B.U.A.S. was when it was born in 1941 it had good godparents and had brought distinction to the University by winning the Hack Trophy in 1955 and being runners-up last year.

A.V-M. H. V. Satterly, A.O.C. No. 64 Group, spoke of the wider link between the R.A.F. and the universities (and of occasional similarities between them in the matter of Treasury stringencies) and said that though the R.A.F. might become smaller than it had ever been before, its power would be very much greater. Its future rested with the universities—especially those leading in science and technology, such as Birmingham.

The matter of size was a point which the Vice-Chancellor, Dr. R. S. Aitken, took up in replying to the A.O.C.'s toast to the University; and in so doing he stressed that it was necessary to guard against being satisfied with more expansion and to insist on quality. Dr. Aitken, who described the U.A.S. as a "commanding loyalty" for a student among the dissipation of interests which surrounded him, presented the Priestley Trophy for the best all-round cadet to Cdt. Plt. A. T. Baker and the Deakin Aerobatic Trophy (a newly instituted award, donated by Mr. Bernard Deakin) to P/O. B. G. S. Peach.

G.M. Award

FOR his skill and courage in directing the rescue of an Army officer in the Welsh mountains last January, and climbing down 200ft of vertical cliff with the injured man strapped to his back, Acting F/S. J. R. Lees of R.A.F. Valley has been awarded the George Medal. An experienced climber, he leads the station's mountain rescue team.

Naval Air Mission

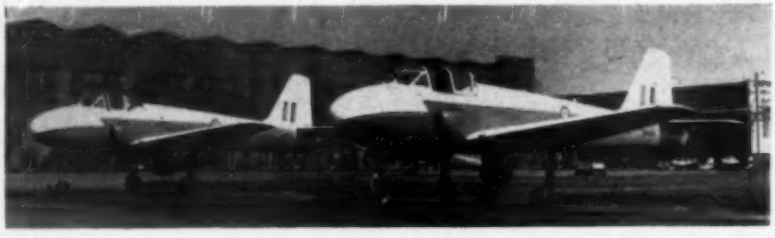
A MISSION of R.N. officers and ratings is to advise the German Federal Navy on the problems of establishing a Naval air arm. Two officers—Cdr. E. M. Brown (head of the mission) and Cdr. R. C. R. Hallett—are already at the German Naval Air H.Q. at Kiel-Holtenau.

U.A.S. Influence

WHEN A.V-M. E. J. Corbally, A.O.C. No. 61 Group, spoke at the Bristol U.A.S. dinner on April 25, he said that any suggestion that absolutely every member of a university squadron should join the R.A.F. was "quite absurd." Nevertheless, they all had their own parts to play in manning the R.A.F.; they had shown qualities of intelligence and character above the average, which meant they would become leaders in their careers and as such could advise the right type of young men to join the R.A.F.

Mr. C. F. Uwins, deputy chairman of the Bristol Aeroplane Co. (and, with Prof. W. Beare, Pro-Vice-Chancellor, the other principal guest), presented the Uwins Trophy—awarded to the best cadet of the year—to P/O. A. I. Sutherland.

Jet Provosts of the C.F.S. aerobatic team at Little Rissington in their new livery—white topside and red underside divided by a blue cheat line passing through an unusually small roundel.



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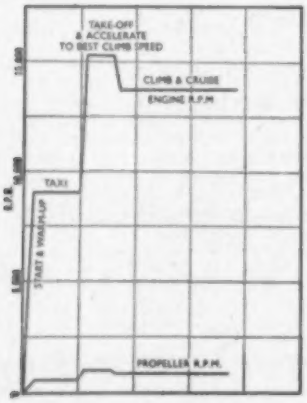

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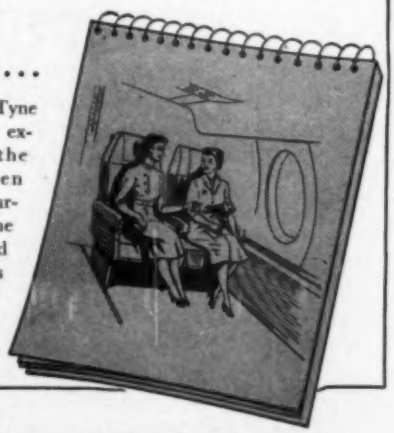

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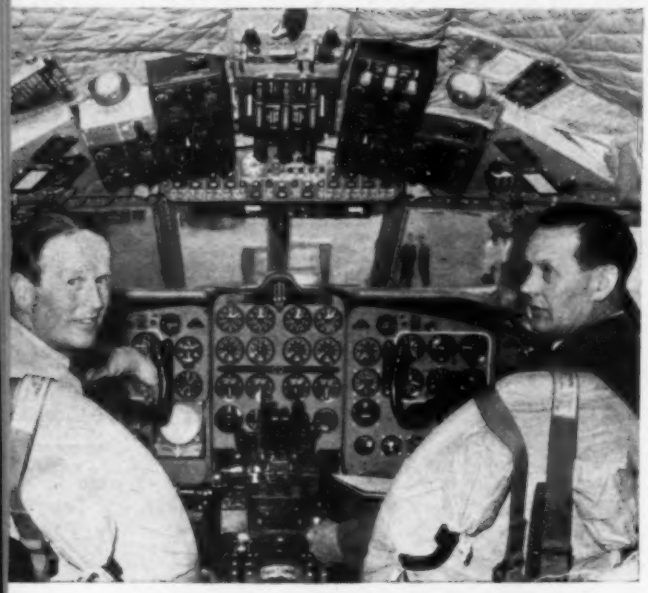


COMET 4s FOR ARGENTINA

A FEW days after the Comet 4's maiden flight the Argentine Government ratified the contract signed between Aerolineas Argentinas and de Havilland for six Comet 4s (*Flight*, April 18).

If ever perseverence deserved a reward, this was it; and de Havilland have now secured a firm overseas order for their Rolls-Royce Avon-powered jet airliner. The company's painstaking three-year sales campaign has not been without its disappointments. Cautious hopes in 1956 that the Capital Airlines order would start the export-ball rolling did not materialize; and since that date D.H.—like other British manufacturers—have been up against the full weight of American competition.

Perhaps D.H. have had more than their share of this competition, because there is not one variant of the nine types of new trunk-route transports being offered—American, French or British, turboprop or turbojet—with which the Comet 4 family has not had to compete. In addition, D.H. have had to contend with remarkable American financing arrangements—of the kind recently offered by Convair to Capital, and, more recently, by another American manufacturer to certain Australian airlines (15 per cent down, progress payments over four years, an offer to buy back at cost price after four years, and attractive trade-in terms for existing piston fleets).

That Argentina has selected the Comet despite these pressures is encouraging. With a production Comet 4 in the air, and an export order in the bag, D.H. have reason to feel happier about Comet prospects for the future. Including the orders from B.O.A.C. (19 Comet 4s) and B.E.A. (six 4Bs), and now Aerolineas Argentinas (six Comet 4s), they probably need to sell another 30 aircraft to break even. Current prospects appear to include C.P.A.L., M.E.A. and T.E.A.L.—the last-named airline, despite Australian pressure to buy Electras, being still technically in favour of the Comet 4C.

Aerolineas Argentinas intend to inaugurate Comet services out of Buenos Aires early next year. It is probable that de Havilland will be able to deliver the first aircraft before the turn of this year without disruption of the B.O.A.C. delivery schedule (which calls for four aircraft before the end of 1958). The Argentine airline uses DC-6s for its overseas services. These extend to London and Amsterdam via Rio de Janeiro, Lisbon and other European cities, and to New York via Rio de Janeiro, Belem, Trinidad and Havana. The schedule between Buenos Aires and New York will be cut by Comets from about 30 to about 15 hours, and the trans-South Atlantic service to London will be cut from about 38 hours to 22 hours.

It is worth noting here the possibility that Comet 4 services out of London to South America may be operated by the Argentine airline before B.O.A.C. gets its own Comet 4s on to that route, unless there has been some contractual arrangement to the contrary.

Latest operating results available for Aerolineas Argentinas (for 1956) show that about 260 million passenger-miles were carried; total capacity ton-miles flown were a little more than 46 million; overall load factor was 68 per cent. A deficit of £3.6 million was returned in the same year, and last year a Government subsidy of £4.8 million was granted.

It is reported from Buenos Aires that delivery of the six Comet 4s is to be completed by March 1960. Total value of the order is officially given as £9 million, excluding spare parts. Argentine engineers and aircrews are expected at Hatfield shortly to begin training.

B.E.A.'s BIG PROFIT

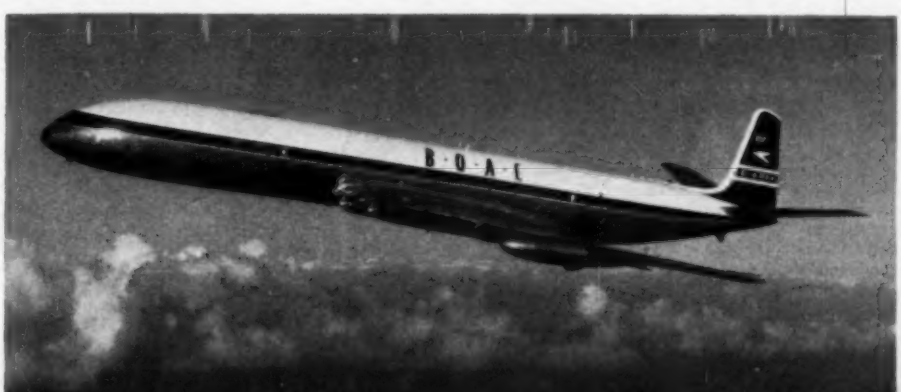
LAST week brought melancholy confirmation of the heavy losses recently sustained by B.O.A.C. In cheerful contrast are the results for the sister Corporation. B.E.A.'s net profit having exceeded £1m for the first time ever. Audited figures are not yet available, but B.E.A.'s preliminary estimates should, on past form, be very close to the final picture. The margin between operating revenue and operating costs appears to be in the region of £1.8m, almost double the amount shown in 1955/1956 and in 1956/1957.

B.E.A. as a whole has now managed to break-even for four years running. But the latest year's results are not only satisfying because they show the largest profit; they also reflect great improvements from an operating—as opposed to a financial—standpoint. In recent years B.E.A.'s net profits have been inflated by (1) low depreciation rates, (2) capital gains from sale of aircraft, (3) earnings from profitable investments (notably Alitalia). Had it not been for the beneficial effect of these items, the net results for 1954/1955 and 1956/1957 would almost certainly have been losses rather than profits, and the profit for 1955/1956 would have been negligible. Capital gain and investment income last year was probably down on previous years, but in any case the position was so improved that a very clear profit must have been made on B.E.A.'s operational side.

This spectacular improvement can be attributed to increasing productivity. Were it not for phasing out of the Elizabethan fleet this index of efficiency would have been even better, for the drop in utilization on these aircraft meant that there was little change in average flying hours per annum over the whole B.E.A. fleet. (The year in which B.E.A.'s overall utilization exceeds 2,000 hr p.a. will be a worthy landmark in the Corporation's life-history.) The main factor leading to increased productivity was the growing share of business handled by the Viscount. The high rate of output realized by these aircraft, coupled with a firm control over the total number of staff employed, saw capacity grow by 15 per cent, while employment rose by only 5 per cent.

Capacity also outpaced traffic, load-factor dropping as a result from 64.5 to 63.7 per cent. This could have had an obviously detrimental effect on profitability were it not for an increase in the proportion of passenger traffic carried. It is likely that loss from the fall in load-factor was more than balanced by the improvement in average revenue rates.

Lord Douglas commented on "intensification of our seasonal traffic problem." The winter trough this year was exaggerated by the slowing-down of airline traffic being experienced in many parts of the world, and the introduction of economy-class fares across the North Atlantic is bringing unprecedented numbers of a highly volatile class of traffic to Europe in the form of holidaymakers from North America. As a large proportion of this traffic breaks journey in the U.K. and proceeds by B.E.A. across the Channel,



Last week was an important one for the Comet 4: there was the Argentine order discussed above, and the flight of the first production aircraft, right. The top picture, taken before the second flight, shows John Cunningham (left), chief D.H. test pilot, with Comet development test pilot Pat Fillingham.

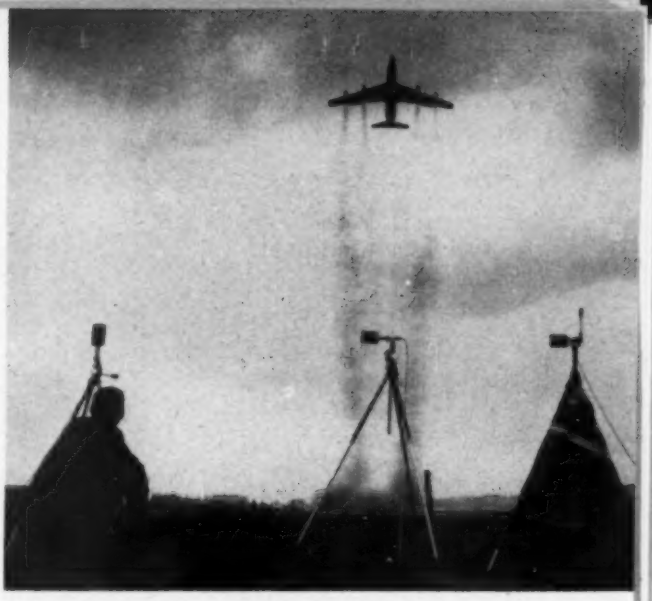
CIVIL AVIATION . . .

the seasonal variations experienced by the Corporation will be aggravated.

Few forecasters would wish to pronounce on the results that will be achieved by B.E.A. in the current year. Operationally their position will improve greatly, with Viscounts taking over virtually all the international services, the mixed-class V.806 seeming to be very well tailored to traffic needs. (This aircraft is now introducing the first mixed-class services to be offered by the Corporation.) But in the background is the haunting fear of continuing recession. B.E.A.'s consolation is that it is probably better placed than any other European airline to face inclement economic weather.

B.E.A. TRAFFIC RESULTS—1957-58

	Financial year ended March 31 1958	Financial year ended March 31 1957	Variation (per cent)
Capacity ton-miles offered	160,282,000	139,079,000	+15.2
Load ton-miles sold	102,062,000	89,685,000	+13.8
Revenue load factor (per cent)	63.7	64.5	− 1.2
Passenger load factor (per cent)	68.5	70.3	− 2.6
Passengers carried	2,765,621	2,461,065	+12.4
Passenger miles flown	935,756,000	808,872,000	+15.7
Freight ton miles	9,925,800	9,227,800	+ 7.6
Mail ton miles	3,599,500	3,622,600	− 0.6
Aircraft miles flown	33,205,000	30,155,000	+10.1
Revenue hours flown	190,500	181,700	+ 4.8
Staff productivity (c.t.m. per employee)	14,560	13,240	+10.0



Noise-measurement tests of the Boeing 707 are seen here in progress at Seattle. A production 707-120 climbs away at 225,000 lb with its J57s at maximum thrust with water injection. This picture was taken 10,500ft from beginning of take-off. Tests continue.

B.E.A. VISCOUNT 802 LOSS

THE circumstances in which B.E.A.'s Viscount 802 G-AORC crashed last week near Prestwick are not yet clear. The aircraft was on charter to B.O.A.C. and was flying from London to Prestwick to pick up 24 people. It crashed at the Hill of Barnweil, Craigie, 4½ miles E.N.E. of Prestwick at 2210 hr G.M.T. on April 28. The crew of five, with the exception of one stewardess, were injured, but all got clear of the aircraft before it was totally destroyed by fire. According to B.E.A., preliminary investigations indicated that there had been no defect in the engines or airframe.

This is the third Viscount 802 written off by B.E.A. during the last seven months, fortunately without loss of a fare-paying passenger. The accident last October to G-AOJA, flagship of B.E.A.'s 802 fleet, when all seven on board—a crew of five and a B.E.A. official and his wife—lost their lives, is still being investigated; preliminary investigations, which lasted three months, caused the Minister of Transport to order a public inquiry. The date of this inquiry has not yet been decided. The circumstances of the Nutts Corner accident were that, on completion of a G.C.A. talk-down, the pilot took normal action to overshoot. Almost immediately afterwards the aircraft crashed near the upwind end of the runway and was completely destroyed.

A second Viscount 802 accident occurred on November 17 last, when G-AOHP, on the regular night-freight service from London to Copenhagen and Hamburg, made a forced landing and was written off. The crew of two were unhurt. The cause of this accident has now been established by the Danish authorities, and it is understood that B.E.A. are in full accord with the findings. The report may or may not be published shortly.

The latest accident was but briefly reported in U.K. newspapers, there being—happily—no loss of life. But it emphasized the disquiet in the insurance world, if not in the minds of the public, about Britain's air safety record during the past year, in which period eleven transport aircraft on the British register have been written off.

NORTHWEST DECIDES?

ONLY one of the major U.S. domestic and overseas trunk carriers, Northwest Airlines, has still to order for the turbine age. For two and a half years this overseas and domestic operator has kept American manufacturers—and indeed those in this country—in suspense while it unhurriedly pondered the merits of the large array of equipment it was being courted to buy.

Now, at last—according to *Aviation Daily*—the airline has decided to buy five Douglas DC-8s and ten Lockheed Electras.

Of particular interest is Northwest's decision in favour of the turboprop for its medium-range operations, notwithstanding the jet competition which it will meet in this sphere. Present equipment includes three DC-7Cs, four L.1049Gs, nine Stratocruisers, 16 DC-6Bs and 18 DC-4s. It is understood that for the first time in its history Douglas has undertaken to buy back existing piston-engined transports as part of the DC-8 deal with Northwest, thus conforming with the Lockheed practice (now almost routine). It is probable also that the last-named company has made a similar arrangement with Northwest; *Flight's* information is that the nine Stratocruisers will be taken by Lockheed as part-payment for the ten Electras.

Northwest flew 155 million load-ton miles in 1957, at a load-factor of 55 per cent. The route network extends across the Pacific from Seattle to Japan, Hong Kong and Manila; from Portland to Hawaii, and from these points to Alaska; and eastwards to Chicago, Minneapolis - St. Paul (the company's headquarters), New York, Washington and Detroit. The route network extends also to Edmonton and Winnipeg in Canada.

T.E.A.L. "BULLDOZED"

STRONG comment about T.E.A.L.'s decision—if indeed it is a firm decision—to buy Lockheed Electras instead of de Havilland Comets came last week from Air Chief Marshal Sir Keith Park. Sir Keith, a New Zealander, is regional executive in New Zealand for the Hawker Siddeley Group. He was A.O.C. No. 11 Group Fighter Command during the Battle of Britain.

Speaking at Palmerston North, New Zealand, last Monday, he said that Qantas had "bulldozed" New Zealand into accepting American Lockheed Electra turboprop airliners instead of British de Havilland Comet jet airliners. He noted that the majority of Tasman's directors [four against two] had decided to buy Comets —"But they were bulldozed by Qantas into accepting Electras so that they would get them at a cheaper price." Sir Keith went on to say: "It is high time, in view of all these troubles, that T.E.A.L. was amalgamated with the New Zealand National Airways Corporation into one big national organization with T.E.A.L. as its overseas division. Then they could stand up to Qantas and tell them where to get off."

He added: "I like Australians, but sometimes they want a slap in the pants."

THE LARGE IRREGULARS

THE C.A.B. are expected soon to pronounce upon the fate of the U.S. non-scheduled airlines. Their decision will probably give permanent recognition to many of the 45 companies at present operating on what is described as a "supplemental basis" (hence the official title "supplemental air carriers").

In addition to charter flights, these airlines may carry individually ticketed passengers between set points on up to ten flights each month. The most publicized such operation was conducted by a consortium of "non-skeds" which operated regular trans-continental services. Last year, after a long battle with the C.A.B. over its legality, and with North American Aviation over its title, the consortium was disbanded. The publicity given to this operation disguised the fact that the activities of the "Large Irregulars" are primarily concerned with military charters, which currently account for about two-thirds of their business.

Traffic is fairly evenly divided between passengers and freight. During the twelve months ended June 30, 1957 (the latest period for which complete statistics are available), the Large Irregulars together carried 103 million freight ton-miles and 904 million passenger-miles. Whereas 85 per cent of freight was military, just over one-half the passenger traffic was civil. Total revenue from these operations was of the order of $50m. The combined fleet consists of about 100 non-pressurized aircraft (of which one-half are C-46s, the balance being DC-3s and DC-4s) and a handful of pressurized L.749s, L.1049s and DC-6s. A few DC-6s and L.1049Hs are on order.

Each of the leading Large Irregulars carried about the same volume of passenger traffic last year as did the bigger local-service

airlines. United States Overseas carried the most traffic (83m passenger-miles), followed by Twentieth Century (80m), Trans National (77m), Great Lakes (74m), Capitol (73m), Transocean (66m), Trans-Caribbean (55m) and Currey (48m). U.S. Overseas, Capitol and Transocean were almost entirely concentrated on military charter, while the others were primarily engaged on civil operations.

The leading Irregulars in the freight field were Capitol (33m ton-miles), Transocean (19m), Overseas National (12m) and Meteor (7m), only the last of these carrying a significant amount of non-military traffic.

It is expected that the C.A.B. decision in the pending Large Irregular Case will result in the granting of permanent status to those companies that appear to be financially sound, that have not violated the Board's policy in the past, and that have been maintained in constant operation. The "ten flight" rule concerning services for individually ticketed passengers will probably remain in force, and operation of an unlimited number of domestic charter flights for passengers or freight is expected to be allowed. As regards international flights the position is less clear, but it seems likely that Large Irregulars will be given greater scope for operating charter freight flights.

Two major problems hang over the heads of these companies. Their relationship with the military authorities has been prejudiced by the short-term nature of their contracts, by the expansion of the Military Air Transport Service, and by insistence on pressurized aircraft for passenger services. Closely tied up with this is the problem of re-equipment. As permanent status will not alone suffice to attract outside funds for this purpose, the Large Irregulars feel that the military authorities should base their contracts on a three-year basis instead of the six-month or one-year periods usual at present. They also hope that a system of government-guaranteed loans similar to those available to local-service carriers for re-equipment purposes can be arranged without delay.

INTERNATIONAL GIANT

PAN American World Airways, Inc.—parent company of which PanAm is the major offspring, but which in addition owns 50 per cent of Panagra and minority shares in at least a dozen other airlines (Aeronaves de Mexico, Avensa, Avianca, C.D.A., C.O.P.A., Cubana, LACSA, LANICA, Mexicana, Panair do Brasil, S.A.H.S.A., U.M.C.A. and Aryana Afghanistan Airways)—has now published accounts for 1957. In this first subsidy-free year operating revenue increased to $313m (making PanAm the world's biggest airline in money terms), but net profit fell from $14m in 1956 to $8m. When allowance is made for the $7.2m subsidy received in 1956, it is easier to appreciate how these results could coincide with a further cut in unit costs.

PanAm's Atlantic routes contributed 36 per cent of the airline's total traffic. The fact that their share of total North Atlantic traffic last year was 31 per cent is a reminder that, theoretically, PanAm alone could handle this entire market. Latin American and Pacific routes respectively contributed 34 and 28 per cent to PanAm's total traffic, leaving the Alaskan services with the balance of 2 per cent.

Passenger traffic increased at a rate of 14.5 per cent and—almost unique among the major world airlines last year—cargo traffic increased even more rapidly at 15.6 per cent. Although still not carrying as much passenger traffic as each of the "Big Four" in the U.S., last year's freight growth brought PanAm world leadership in freight as well as in mail.

The Standard Motor Company takes the credit for this impressive scene at London airport last week. It shows 60 Triumph cars, with the Britannia 102 chartered from B.O.A.C. to bring to England the American purchasers of these cars. Each customer paid $3,300 for the round trip, which includes four weeks' touring on the Continent. A second charter is due to take place tomorrow; a similar one took place last year. The cars will eventually go to the U.S.A. by ship.

CONTRACTORS TO THE STATE

THE Military Air Transport Service has provided the U.S. House Committee on Government Operations with a breakdown of M.A.T.S. airlift contracts by carriers. The annual value of these contracts has been rising in recent years from about $40m three years ago to a current level of $50m (expenditure by the British Government on trooping contracts to independent airlines has been standing at about £6m a year).

While the Large Irregular Carriers were receiving about one-half of M.A.T.S. airlift contract funds in 1955, these airlines are now only getting one-fifth. Their lack of pressurized equipment has been a major factor in the transfer of contracts to scheduled operators, particularly the larger all-freight carriers (Flying Tiger, Seaboard and Western and Slick) whose share of M.A.T.S. funds has increased from 40 to 70 per cent.

In recent years Seaboard and Western has been M.A.T.S. chief contractor, its annual receipts exceeding $10m. However, the financial year ending this coming June will probably see Flying Tiger usurping Seaboard and Western's leading position.

Domestic trunk airlines carry very little M.A.T.S. traffic and the overseas airlines share but a moderate amount. The only two carriers to obtain substantial revenues in this field are PanAm and T.W.A. Whereas P.A.A.'s revenue in the current financial year is expected to be rather less than the $5m earned in 1957, T.W.A.'s revenue will have increased to over $1m.

Among the Large Irregulars, California Eastern Aviation has in recent years been receiving between $4m and $5m annually from M.A.T.S., and World Airways, Capitol Airways and Transocean Airlines will each receive almost $2m this year.

Seen (left) at Short's airfield at Belfast last week is C.P.A.L.'s chief pilot, Mr. Harvey Johnston (centre) taking delivery of his company's second Britannia 314 from Short's chief test pilot, Tom Brooke-Smith (left) and Bristol's chief test pilot, Walter Gibb. The first aircraft was delivered at the beginning of April. Four more will follow.

The Microcell Company have just received an order from B.O.A.C. for all the passenger chairs to be installed in the Corporation's Comet 4 fleet. The picture shows the triple economy-class chair; the different headrests are under evaluation. Microcell also supplied the first-class seats for B.O.A.C.'s Britannias.

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CUNARD ECONOMICS

EVERY year, as the month of May approaches, senior officials of I.A.T.A. must start to wonder what pronouncements concerning the world of air transport will appear in the pages of the annual report of the Cunard Steam-Ship Company. This week's statements by Cunard's chairman, Col. D. H. Bates, are even more biting than those of yesteryear. Having told the shareholders that last year their company paid the sum of £4.5m "required by harbour and port authorities all over the world to enable them to break even" [whether these authorities do in fact break even is open to challenge], Col. Bates quoted a remark made by Sir William Hildred at the recent I.C.A.O. conference on route charges, to the effect that an increase in these charges would hamper the industry just at the moment when it is introducing a new era in air transport. The chairman then asked: "Why should not these extra charges be passed on to the customers?"

To Col. Bates the recent fare increases sought by I.A.T.A. are a sign that "the hard force of the law of economics in air transport" is at last becoming felt. To orthodox economists, however, the opposite appears to be the case, I.A.T.A.'s demand for higher fares being ascribed to the cartel situation prevailing in international air transport. Indeed, much evidence has been produced to demonstrate that if "the laws of economics" really did obtain in this industry, then air fares—particularly across the North Atlantic—would be rather lower than at present, and Cunard's position accordingly worse.

Cunard's decision to postpone building of a new 30,000-ton liner to replace the ageing *Britannic* must be seen not only against the background of a disappointing financial year, but also before the prospect of increasing North Atlantic competition. On the one side are the airlines enjoying an increasingly larger share of total traffic, on the other are a growing number of maritime rivals competing to gain bigger shares in an ever smaller market. Some commentators on the airline scene have forecast a surfeit of seats in the early 'sixties. But when the *France*, the *Rotterdam*, the proposed sister-ship to *United States*, the new $24m Canadian Pacific liner, and more German, Greek and Italian vessels all come into service in the early 'sixties there will surely be the strong possibility of unfilled berths on the sea also.

BREVITIES

THE first flight of the DC-8 is now planned for May 15. Although it was originally scheduled for March, Douglas remain confident that certification will still take place in October 1959.

* * *

The possibility that the Fokker Friendship may be built under licence by Saab in Sweden is reported from Holland.

* * *

The air transportation conference organized by the American Institute of Electrical Engineers will be held in Buffalo, New York State, from June 25 to 27.

* * *

The British Airline Pilots Association are to hold a ball, to celebrate their twenty-first anniversary, at the Royal Festival Hall, London, on Friday, May 16. Dancing will be from 11 p.m. to 5 a.m.

* * *

Apart from small areas which have yet to be hand-filled, Gatwick's runway and taxi tracks are complete. The railway station will probably be opened on May 28, prior to formal inauguration by the Queen on June 9.

* * *

Appointments in B.K.S. Engineering, Ltd., include Mr. F. T. Taylor as general manager (formerly chief inspector) and Mr. A. E. Johnson as commercial manager (formerly chief engineer). Mr. J. Belcher now becomes chief inspector.

* * *

Air-India are to operate a Super Constellation proving flight to Moscow via Tashkent on May 18. Aeroflot will make a reciprocal Tu-104 flight into New Delhi. Regular services by both airlines between the two capitals will begin soon afterwards.

* * *

The official inquiry at Munich into the B.E.A. Elizabethan accident on February 6 was adjourned after two-and-a-half days. It was stated that further evidence about the effects of wing-icing was needed before final judgment could be reached, but the following possible causes could be ruled out: (1) engine failure, (2) other defects of technical equipment of the aircraft, (3) condition of the fuel, (4) loading and trim, (5) flight-safety control and meteorological services, (6) the airport and its equipment.

* * *

Newly elected chairman of B.A.L.P.A.'s technical committee is Capt. M. W. Broom of B.E.A.

* * *

A fully illustrated seven-page feature on Idlewild airport is included in the April 30 issue of one of *Flight's* associated journals, *The Architect and Building News*.

* * *

An Aeroflot Tu-104 has been chartered by Horizon Holidays to take tourists from London to Moscow. The first flight leaves on July 26; the flight time will be 4½ hours. Cost of the inclusive tour is £156.

* * *

Hunting-Clan were awarded a Government charter to carry Mr. Selwyn Lloyd, the Foreign Secretary, and 45 advisers and officials to the NATO Conference at Copenhagen last weekend.

* * *

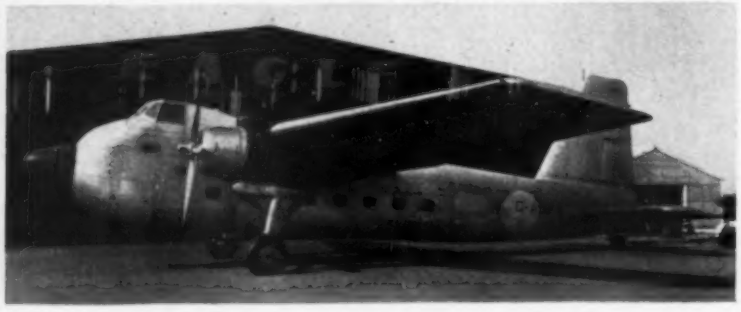
T.W.A. expect to receive their first Boeing 707-120 for crew training in December (or earlier), and should have six more in the following two months. The first T.W.A. 707-320 is likely to be delivered in October 1959. American Airlines first Boeing 707-120—due in service before Christmas—should be rolled out on June 24 and flown on July 29.

* * *

B.O.A.C.'s two D.H. Comet 2Es are to be used on proving flights across the North Atlantic to Gander via Keflavik as from May 11. These flights may in due course be extended to New York to explore the feasibility of regular Comet 4 operations across the North Atlantic. The Comet 2E's Rolls-Royce RA.29 proving programme is now virtually completed.

The latest addition to the Rootes range of commercial vehicles is this cargo-lift truck. It is in use at London Airport with B.O.A.C. and PanAm (as shown here), and is based on a Commer forward-control wheelbase. Its platform will lift loads of up to five tons as high as 13ft.

Now being refurbished by Eagle Aircraft Services at Blackbushe is a Bristol 170 Wayfarer Mk 2, G-AGPV, one of the first Wayfarers built. It has now been restored to its original 1946 civil registration, having been in use (with R.A.F. roundels) as a Ministry of Supply research aircraft—as indicated by its experimental radome. The new owners, for whom it is being fully "civilianized" by Eagle, are R. A. Short Aviation. It will be operated as a 44-52 seat passenger/cargo aircraft.



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SW/18

CORRESPONDENCE

The Editor of "Flight" is not necessarily in agreement with the views expressed by correspondents in these columns. The names and addresses of the writers, not for publication in detail, must in all cases accompany letters.

The First Aeroplane Flight in Britain

From Dr. G. W. H. Gardner, C.B., C.B.E., D.Sc., Director, R.A.E.

EARLY this year, the 50th anniversary of S. F. Cody's historic flying achievements at Farnborough, the Royal Aircraft Establishment reviewed the evidence for the date of the first powered aeroplane flight in Great Britain. Various sources had quoted dates ranging from May 16 to October 16, and in 1949 the date of May 16 was inscribed on a plaque attached to Cody's Tree.

A search of contemporary official papers produced nothing earlier than a report to the War Office, written on October 16, 1908, by Colonel Capper, Superintendent of the Balloon Factory. This letter gave an account of the flight made on that morning of 1,390ft (the same flight that was reported in *Aeronautics* for November 1908, and described by Cody to the Aeronautical Society in December 1908). Evidently, Colonel Capper regarded this as the first real flight, although he claimed that the machine had "left the ground for short runs, at a height of one or two feet on several occasions."

Clearly it is necessary to distinguish between an undoubted sustained, powered and controlled flight and a "powered leap," as Mr. Charles Gibbs-Smith points out in his article "Half-Century of Powered Flight" (*The Times*, April 14, 1958, page 11). We agree with others that nothing much less than a quarter of a mile would seem to remove all reasonable doubt that a flight was indeed sustained. In accordance with this definition, the first successful flight of a powered aeroplane in this country was that by Cody on the morning of October 16, 1908. Mr. Gibbs-Smith, in the course of research for his forthcoming history of aviation, has arrived independently at a similar conclusion.

We at the Royal Aircraft Establishment are proud to honour Cody as the first to fly a powered aeroplane in Great Britain; but it is unnecessary, and a disservice to his memory, to claim more on his behalf than either he or the Factory claimed at the time. We have, therefore, revised the inscription on Cody's Tree to read:—

> "S. F. Cody measured the thrust of his first aeroplane in 1908/9 by tying it to this tree. Nearby he made his first tests with his powered aeroplane on 16th May, 1908, and his flight of 1,390 feet on 16th October, 1908, was the first sustained aeroplane flight in Great Britain."

Farnborough, Hants. G. W. H. GARDNER.

The Sovereignty of Airspace

MANY thanks to your contributor Roger Bacon (April 25) for awarding me full marks. I must have passed some sort of test and I'm dying to know what it is.

I hope my little article ("The Law of Mediæval Space," March 28) didn't suggest that I don't *care* about the extent of sovereignty in the airspace. What has me worried is that the scientists couldn't care less what the lawyers do, whilst the lawyers are busy lacing space with verbal mumbo-jumbo. The result will be to ensure that outer space can be used only as a military playground subject to intensive political pressures which will have nothing to do with space technology. The death of the Geneva Convention on the extent of coastal sovereignty over the high seas is to me a vivid display of the incompatibility of science and the law. Lawyers may sometimes forget that rules of law are always arbitrary and can persist only by consent. This is fine until the consenting parties have the nakedness of their consent revealed by the fruit of the tree of scientific knowledge: such as (to continue the analogy) studies in ocean topography and fish conservation.

If there was this much disaster over the traditional three-mile limit of coastal sovereignty, can you imagine the size of chaos in the upper air?

Incidentally, I am not so worried about the ICBM as I am about the future activities of SAC (Earth Satellite Division). I envisage a round dozen satellites at a comfortable orbit about 1,000 miles up—virtually free from any drag. Each satellite will carry the latest H-bomb, a directionally controllable rocket set, actuators and a powerpack activated by remote radio. On receipt of a suitable signal from earth or from a scanner satellite, any H-satellite can be given a directional impulse sufficient to kick it into a suicide-spiral on to some earthly target. All computing apparatus can be on the ground.

London, E.C.2. HAROLD CAPLAN.

Historic Military Aircraft: A Reply

I HAVE a certain amount of sympathy with what Mr. Collick [April 25] says about performance figures, but one must beware of creating difficulties or exaggerating their importance. I should be interested to know precisely what, in his view, would constitute a "truly representative" or "more average" set of performance figures for any type of aircraft, and what his criteria would be for the establishment and acceptance of such figures. I should be even more interested to know how, at this late date, irrefutable performance figures of this kind can be established for 1914-18 aircraft.

In the case of the figures quoted by Mr. Collick for a Short 184 with the 240 h.p. Renault engine, the aircraft concerned was a Short-built 184 which was tested at a loaded weight of 5,560 lb. The machine which established the performance figures quoted in my article was a Sage-built Short 184, and it was tested at a loaded weight of only 5,190 lb. Surely the difference in weights might account for the difference of 4½ knots in top speed? It certainly might betoken a different military load of lower drag.

In any case, it seems odd to me that Mr. Collick is willing to accept 69.5 kt (80 m.p.h.) at 5,560 lb as representative, since he says that in a dozen other cases Short 184s flown at not more than 4,700 lb did not exceed 81 m.p.h., and implies that the twelve constitute something like the norm. Yet the 5,560-lb machine, although at least 860 lb heavier, had quite as good a performance—does that not make it rather above average, too? I do not know how the acceptance-test conditions compared with those of the official type tests, but I doubt whether they would be comparable.

Different contractors were liable to produce aircraft of differing quality, sometimes incorporating modifications of their own and thereby altering the empty weight of the aircraft. The fitting of different types of airscrew affected performance; so, too, did the amount of water soakage in the floats. The following table may help to illustrate my point; it is compiled from official test reports, and all figures relate to Short 184 seaplanes fitted with the 240 h.p. Renault engine (255 h.p. at 1,300 r.p.m.). Note the varying weights: especially the "empty" weights set out in Column 3.

Date of trial	Contractor	Weights (lb)					Max. speed (kt) at		Climb (min) to		Service ceiling (ft)	Endurance (hr)
		Empty	Mil. load	Fuel and oil	Crew	Loaded	2,000 ft	6,500 ft	2,000 ft	6,500 ft		
24.3.17	Short	4,056	438	662	360	5,516	64	—	10.6	—	4,000	4
30.5.17	Short	3,798	668	734	360	5,560	69.5	61	8.25	42.5	5,700	4½
17.7.17	Sage	3,514	650	666	360	5,190	74	68	9.3	51.5	5,000	5
17.7.17	Phoenix	3,496	650	738	360	5,244	66.5	60.5	9.1	46.6	5,500	—

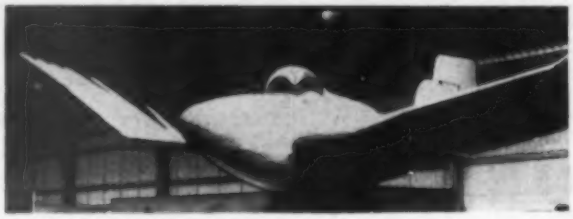
This kind of information could have been provided as part of the original article, but there is obviously a limit to the amount of space. I chose to reproduce performance figures which showed what a Renault-powered Short 184 could do; I assumed that readers would deduce that the figures were obtained at the weights quoted. If I had chosen the figures established on March 24, 1917, I would probably have received (and well deserved) the reproaches of those Short pilots who had got at least ten more knots out of their Renault-powered 184s!

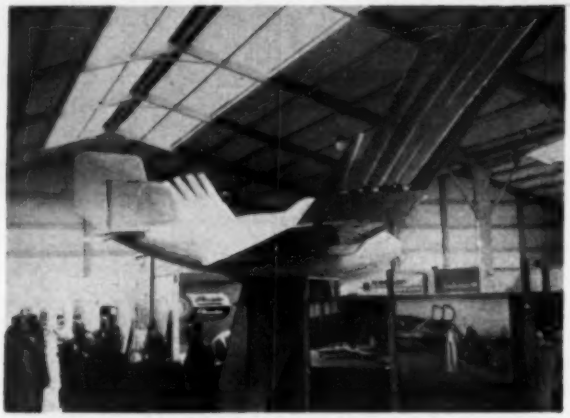
Conscious that the more fastidious student might have doubts about accepting only one set of performance figures of each type or variant, I did my best to present (where possible) balanced assessments in *British Aeroplanes, 1914-18*, as Mr. Collick will, I hope, appreciate if he reads pages vii and viii of that book and then goes on to study the performance tables for such types as the Bristol Fighter, D.H.4, S.E.5/5a, and Sopwith Camel. One must accept the surviving official test reports for what they are: they contain facts and figures which one must assume to have been recorded faithfully, and it would be unwise to regard any one of these reports as being typical of all aircraft of the type concerned.

I will not quibble about acceptances, deliveries, or the completion thereof, but I should like to point out to Mr. Collick that the first Phoenix batch of Short 184s was correctly quoted as 8368-8379 on page 999 of the issue of December 28, 1956: the entry on page 23 of the issue of January 4, 1957, was a printing error.

Lastly, I sorrow to note that Mr. Collick persists in calling the aircraft the Short *S*184—especially after the trouble I took (final paragraph, page 968, issue of December 21, 1956) to explain its correct designation!

Birmingham, 32. J. M. BRUCE.





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Guaranteed to make any visitor stop, stare and blink on entering the display hall was the prominently mounted Swan I ornithopter —or *Schwingenflugzeug*, to quote the designer, Walter Filter. This single-seater prototype has a tow-hook under the nose and will be aero-towed as a sailplane, the occupant using leg-muscle power after release to operate a mechanism which flaps the outer wing sections and, it is hoped, delays the effect of gravity.

This aircraft has not yet flown, and an increase in tailplane area may well be effected before the first flight. The angle of incidence of the five feather-like aerofoils forming each of the two outer wing panels varies throughout the flapping cycle.

The 13-metre Swan 1 has a flying weight of 730 lb and is to be followed, once the principle of the design has been proved in flight, by a two-seater, 15-metre Mk 2 weighing 1,210 lb and a six-seater, 20-metre version of 2,980 lb. The Mk 2 would be powered by a turbine engine for take-off, and the Mk 3 would have a fuselage-mounted power unit to actuate the flapping wings.

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No longer just a novel prototype, the RW.3 has been ordered by customers in Sweden, Brazil, Mexico, Japan and Spain, and is the subject of firm interest from Switzerland, Australia and Canada. Five aircraft have been built, a delivery period of 3-4 months is quoted, and the production rate is planned to rise to ten machines per month by July. A demonstration tour of the United Kingdom is expected to begin later this month.

Compared with the prototype Multoplane, the production version (built to conform with U.S. Civil Air Regulations, Part 3) has a revised instrument panel and is 110 lb lighter. A 90 h.p. Continental could replace the standard Porsche engine if required. A German C. of A. has been granted to the prototype and is expected in the immediate future for the production machine. Ex-works price of the RW.3 is DM 29,800 (about £2,540).

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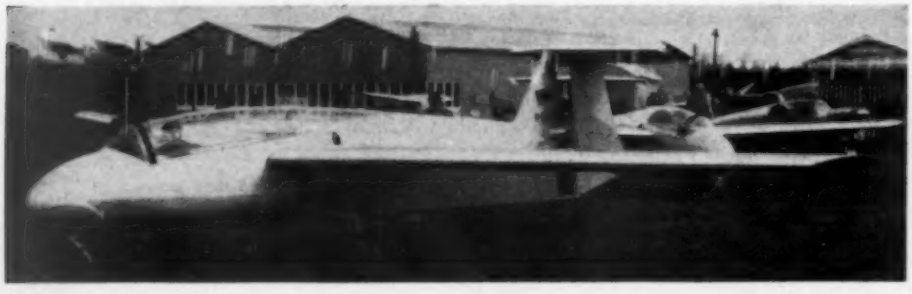

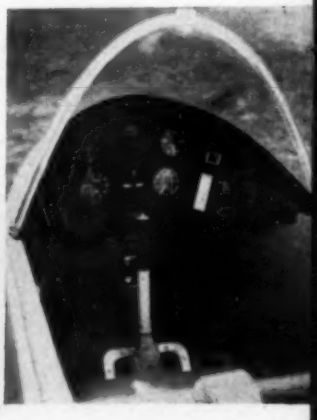

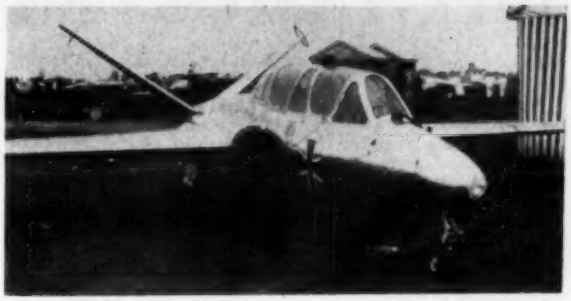

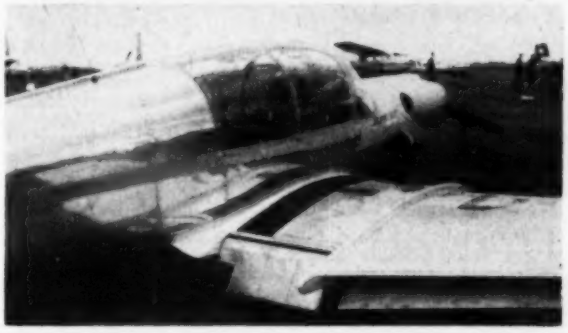

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Among the exhibits in the display hall was a wide range of R.F.D., Irving and Martin-Baker equipment (by Dr. Gerhard Sedlmayr's Autoflug company of Hamburg); and a promising light-weight V.H.F. radio set made by Max Egon Becker of Baden-Baden. The Becker equipment, designated AR 24, is particularly suitable for sports and touring aircraft—and, indeed, was fitted in many of the aircraft displayed at Hanover. It has 24 crystal-controlled transmitter channels, variable receiver tuning over the frequency range 108-118 mc/s (navigation) and 118-132 mc/s (communication), and a total weight (including power unit and amplifier) of only 21 lb 3 oz.

Although not exhibiting at Hanover, the "northern union" group of aircraft companies—Focke-Wulf, Hamburger Flugzeugbau and Weserflug—are actively involved in West Germany's current programme. This work includes the licence-production of the Nor-atlas transport and (by Focke-Wulf/Blume) the Piaggio P.149D.

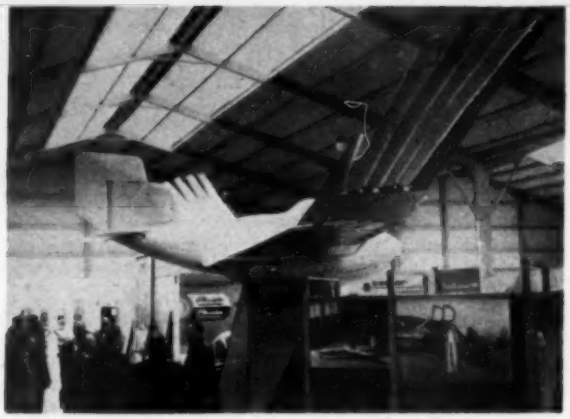
Among the foreign aircraft shown at Hanover were a representative selection of U.S. business and executive types which included the current Beech and Cessna ranges, Mooney Mk.20A, Helio Courier and the first Piper Comanche to be delivered to Europe (N5089P). Representing Britain, Czechoslovakia, France and the Netherlands respectively were a de Havilland Dove; Super Aero, L-60 Brigadier and Zlin Z.226T Trener; a Jodel D.117; and an H.3 Kolibrie ramjet helicopter.

Weather during the first few days of the exhibition (which was held from April 27 to May 6) was wet, cold and gusty—not conducive at all to the sports-flying gala that should have been. Top honours for effective demonstration flying under appalling conditions undoubtedly went to R. G. Van der Harten (Kolibrie), Heinrich Schaefer (Do.27) and, especially, to Miloslav Kocir in the Zlin Trener.

Throughout the period of the Industries Fair, a chartered B.E.A. Whirlwind was kept busy carrying international passengers who were in a hurry from Langenhagen Airport to the site of the main fair. At the fair, British aircraft-industry representation was proportionately even weaker than in the aircraft park at Langenhagen, the only major companies choosing to exhibit being B.E.A. and D. Napier and Son.

K. T. O.

Lower three pictures, from the bottom: Scheibe Sperling, with Kolibrie helicopter in background; Pützer Elster; and Klemm Kl.107B.



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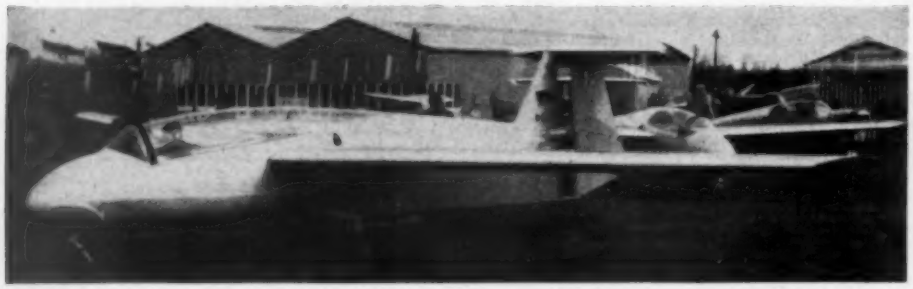

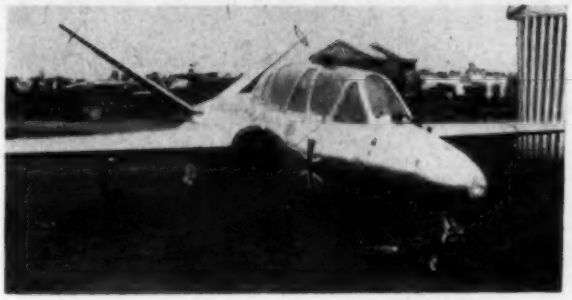

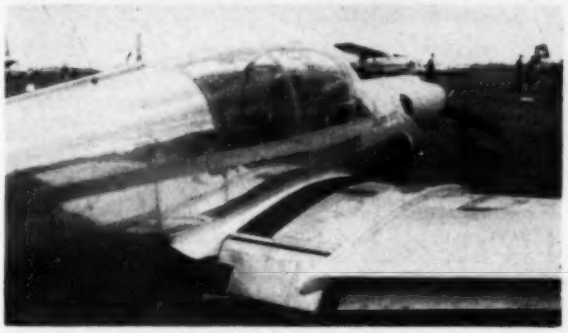

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Among the exhibits in the display hall was a wide range of R.F.D., Irving and Martin-Baker equipment (by Dr. Gerhard Sedlmayr's Autoflug company of Hamburg); and a promising light-weight V.H.F. radio set made by Max Egon Becker of Baden-Baden. The Becker equipment, designated AR 24, is particularly suitable for sports and touring aircraft—and, indeed, was fitted in many of the aircraft displayed at Hanover. It has 24 crystal-controlled transmitter channels, variable receiver tuning over the frequency range 108-118 mc/s (navigation) and 118-132 mc/s (communication), and a total weight (including power unit and amplifier) of only 21 lb 3 oz.

Although not exhibiting at Hanover, the "northern union" group of aircraft companies—Focke-Wulf, Hamburger Flugzeugbau and Weserflug—are actively involved in West Germany's current programme. This work includes the licence-production of the Noratlas transport and (by Focke-Wulf/Blume) the Piaggio P.149D.

Among the foreign aircraft shown at Hanover were a representative selection of U.S. business and executive types which included the current Beech and Cessna ranges, Mooney Mk.20A, Helio Courier and the first Piper Comanche to be delivered to Europe (N5089P). Representing Britain, Czechoslovakia, France and the Netherlands respectively were a de Havilland Dove; Super Aero, L-60 Brigadier and Zlin Z.226T Trener; a Jodel D.117; and an H.3 Kolibrie ramjet helicopter.

Weather during the first few days of the exhibition (which was held from April 27 to May 6) was wet, cold and gusty—not conducive at all to the sports-flying gala that should have been. Top honours for effective demonstration flying under appalling conditions undoubtedly went to R. G. Van der Harten (Kolibrie), Heinrich Schaefer (Do.27) and, especially, to Miloslav Kocir in the Zlin Trener.

Throughout the period of the Industries Fair, a chartered B.E.A. Whirlwind was kept busy carrying international passengers who were in a hurry from Langenhagen Airport to the site of the main fair. At the fair, British aircraft-industry representation was proportionately even weaker than in the aircraft park at Langenhagen, the only major companies choosing to exhibit being B.E.A. and D. Napier and Son.

K. T. O.

Lower three pictures, from the bottom: Scheibe Sperling, with Kolibrie helicopter in background; Pützer Elster; and Klemm Kl.107B.

Attending this Hawker Hunter at Dunsfold is the fuel-gauge calibration van which Waymouth Gauges and Instruments, Ltd., can now place at the disposal of aircraft manufacturers wishing to have checks made of pre-production and production installations.

THE INDUSTRY

Fairey Changes

NEW senior executive appointments in the engineering division of the Fairey Aviation Co., Ltd., have been announced. Mr. Robert L. Lickley, technical director and chief engineer, has now relinquished the latter appointment. Dr. G. S. Hislop, formerly chief designer (helicopters) has been appointed chief engineer (aircraft); and Mr. L. R. E. Appleton, head of guided weapon design and development, becomes chief engineer (Heston).

Dr. Hislop will be in charge of all design (including flight development), technical office, drawing office and laboratory work; and Mr. Appleton will be responsible for the guided weapons, nuclear engineering and electronic instruments teams at Heston. Both will be directly responsible to the technical director.

Rebecca Orders

AMONG orders received recently by the electronics division of Murphy Radio, Ltd., for Rebecca Mk 8 equipment is one from the Indian Air Force for their Hawker Hunters. Deliveries are being made to B.O.A.C. of Mk 8B equipment for their D.H. Comet 4s; and the Department of Transport for South Africa has just ordered a quantity of Eureka Mk 7 beacons—to be installed at seven principal airports—following the S.A.A. decision to fit their Viscounts with D.M.E. in the form of Mk 8 Rebecca.

New Caliper Gauges

FROM Aylesbury Turned Parts (True Screws), Ltd., of Britannia Street, Aylesbury, Bucks, come details of the Helios range of precision measuring instruments—vernier calipers, height gauges and dial calipers—for which they are sole U.K. agents.

Lately introduced in this range—which originates in Western Germany—are a vernier caliper with hinged jaw and a combined caliper giving English and metric readings. The first-named is a caliper gauge of orthodox construction, with the usual internal and external measuring faces, but with the important exception that the sliding member can be swung sideways to permit measurement over two points not lying on the same axis.

The second instrument is again basically an orthodox internal and external caliper gauge, but is provided with a Plexiglas-protected dial giving metric and English readings in addition to the direct readings from the thumb-roller sliding member.

Dart Engine Overhaul Stand

The Morfax stand for Dart engines, described in the news-item above.

ILLUSTRATED here is a new strip/assembly stand developed and manufactured by Morfax, Ltd., of Willow Lane, Mitcham, Surrey, for overhaul of Rolls-Royce Dart RDa.6 and RDa.7 engines. The stand has been approved by the engine manufacturers and is to be referred to in their overhaul manual.

The engine can be rotated in both planes and locked in any position. Rotation in the horizontal plane is by a tommy-bar attachment to the main frame, while vertical rotation is either by a reversible air motor or a handwheel operating through a reduction gearbox.

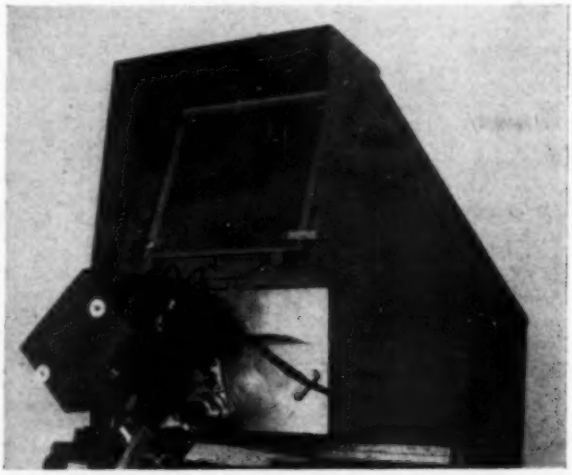
The tubular chassis forms an air reservoir and Schrader unions are fitted at strategic points for use with pneumatic tools. A triple unit comprising air/water separator, control valve and lubricator protects pipework and air tools. The engine is supported in the inner ring by three links offset to counteract expansion.

Details include a drip-tray with gauze and drain-cock, tool trays and wheels (castor or fixed) with neoprene tyres resistant to synthetic oils.

Leading-edge Form Projector

THE instrument illustrated below has been designed by the West London Optical and Tool Co., Ltd., of Witney, Oxfordshire, for the optical projection of the leading edges of scale prototype aerofoils. It provides an accurate × 20 magnification of the leading edge, and is applicable to wings with sweepback of from 15 to 55 deg.

A point source of illumination is provided by a standard 100W projection lamp and the lamphouse itself can be angled or positioned up to 45 deg either side of centre, thus providing a means of checking the complete contour of the leading edge.



Leading-edge form projector (West London Optical and Tool Co.).

The instrument is supplied for bench mounting, but without a work-holding fixture. The makers state that the latter, apart from holding the work to be checked, should have an adjustment allowing for correct angle of sweepback and a form of movement to enable the leading edge to be viewed at any station.

IN BRIEF

Mr. W. A. Dymond has been appointed commercial manager of The Photographic Survey Corporation, Ltd., of Toronto.

* * *

Visitors to the Bognor Regis airstrip of Lec Refrigeration, Ltd., are now able to use the Telex facility (No. 8687) recently installed at the company's factory there.

* * *

Mr. D. Milne, C.A., has been appointed secretary of William Jessop and Sons, Ltd., and their associated company J. J. Saville and Co., Ltd., and Mr. J. V. Gregory has been appointed assistant secretary, following the death of Mr. F. Briggs, F.C.I.S., who was secretary of both companies.

* * *

Some 300 apprentices and over 200 guests attended the annual dinner of Dowty Group apprentices at the Town Hall, Cheltenham, on April 25. General Sir Brian Robertson, chairman of the British Transport Commission, was the principal guest; and other speakers were the Mayor of Cheltenham, Cllr. C. G. Irving; Mr. Michael Crouch; Sir Godfrey Ince; and Sir George Dowty.

* * *

A new type (HT 125) of lightweight rechargeable battery (0.125 amp hr nominal) utilizing strips of from one to ten cells which can be arranged in any desired form before potting in resin, has been produced by Venner Accumulators, Ltd., Kingston By-Pass, New Malden, Surrey.

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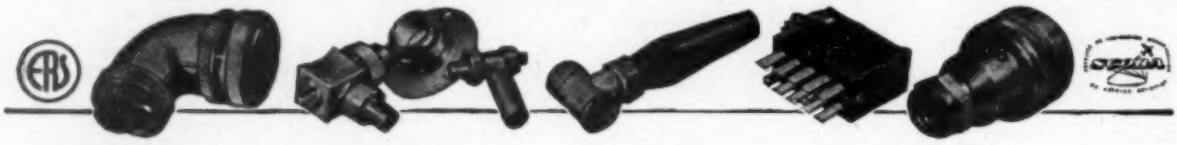

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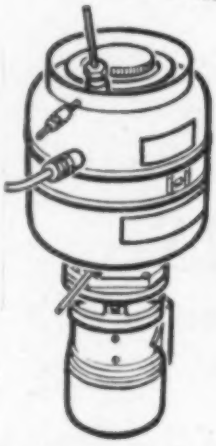

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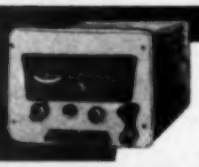

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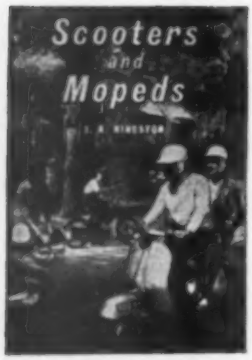

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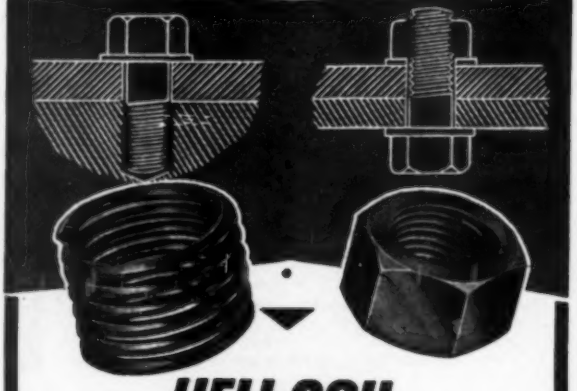

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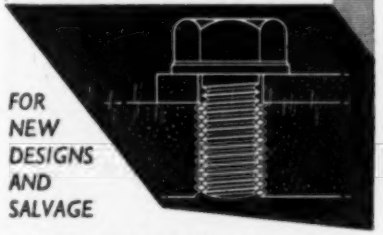

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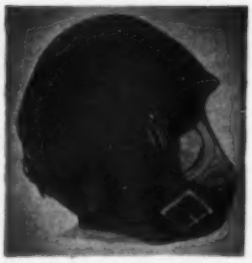
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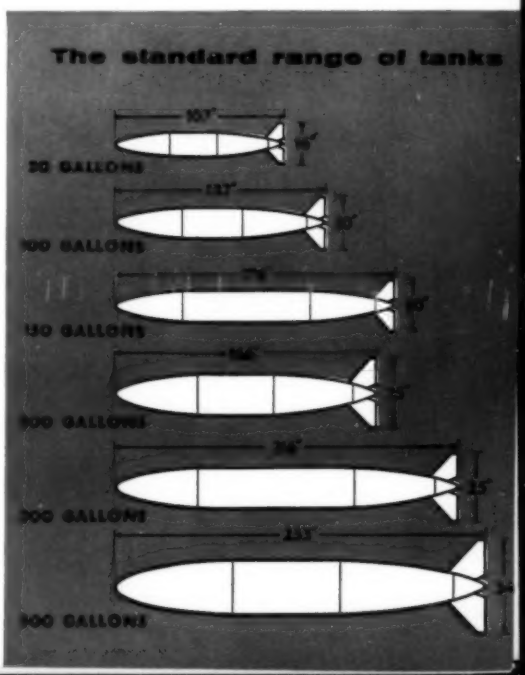
Their aerodynamic superiority to aluminium tanks has been proved at supersonic speeds and under combat conditions.

Bristol plastic drop-tanks are available for the Hawker Hunter, Armstrong-Whitworth Sea Hawk, English Electric Canberra, de Havilland Venom, Sea Venom and Sea Vixen, Westland Wyvern, Folland Gnat, Hunting Provost and Jet Provost, Supermarine Scimitar, Fairey Gannet, and Fiat G 91.

Bristol drop-tanks are under development for many other types and are being built under licence in Holland, Belgium and France.

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